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I

TROPICAL FRUITS FOR SOUTHERN FLORIDA AND CUBA AND THEIR USES

BY

DAVID STURROCK

PUBLISHED BY
THE ARNOLD ARBORETUM OF HARVARD UNIVERSITY
JAMAICA PLAIN, MASS., U. S. A.
1940

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DEDICATED

TO THE

PIONEER HOMESTEADERS

OF

SOUTHERN FLORIDA

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PREFACE

This popular consideration of the subject matter included is published with the belief that the little volumn will meet a need particularly among the permanent residents of southern Florida, especially those interested in growing fruits in the home garden. An attempt has been made to compile reasonably comprehensive data appertaining not only to the rather impressive list of exotic fruiting shrubs and trees of subtropical and tropical origin, now more or less thoroughly established in Florida, but also the care and propagation of the plants, and the uses that can be made of their fruits. These exotic plants have come from many parts of the world—Africa, India, China, Malaysia and the Philippines, Polynesia, Mexico, the West Indies, and various parts of Central and South America. In their native lands some of them are distinctly important in home economy, and there is no reason why many of them should not become equally important in the home economy of Florida. With reference to the utilization of fruits a special section has been devoted to the technique of making jams, jellies, and pastes.

The data appertain particularly to those species that may be successfully grown in southern Florida, for here is the only area within the continental United States where the general climatic conditions approach the tropical. It is true that some of the species can be grown in other parts of the south and southwest, but many of them demand reasonably high temperatures and ample moisture. It is the hope that this work may induce many local residents more fully to appreciate what is actually available to them in this favored part of the United States, and that some may be inspired to develop local industries based on these exotic fruits many of which cannot successfully be grown in other parts of the country.

DAVID STURROCK

Superintendent of the Atkins Institution
of the Arnold Arboretum of Harvard University
Soledad, Cienfuegos, Cuba

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TROPICAL FRUITS FOR SOUTHERN FLORIDA AND CUBA AND THEIR USES

INTRODUCTION

To the average resident of southern Florida, the available fruits are either unknown or very poorly understood. In a new country, where the majority of the residents have not yet settled down to feeling at home, the ideas of food are naturally those of "back home," with but a passing thought to the unusual fruits sometimes seen, sometimes tasted, and generally set aside as being too strange. Winter residents are beginning to take an interest in these fruits, and at present there exists a small but growing demand for some of them and in products manufactured from them, through private shipments during the summer months. A knowledge of these fruits and their uses is gradually spreading throughout the nation, and the demand for them is increasing each year.

Some day, southern Florida will have new industries as the fruits become better known and the demand for them increases. Commercial orcharding as a major industry for this region is still some years away, however, and the present need for practical knowledge of fruit-growing here lies chiefly in the desire of the home-owner to plant for domestic use.

The attractiveness of southern Florida during the summer months is becoming more appreciated. This section of the country is ceasing to be simply a winter resort, as it has great summer possibilities that are gradually being realized. The population is rapidly increasing, and the present trend is toward urban and rural homes, with a reasonable area of planting space around them. It is but natural that a good part of this space should be devoted to fruiting plants. The problem confronting the owner is "what to plant." The first thought is usually of the citrus fruits, then the avocado and the mango, but these are only a few of the possibilities.

In the rural home with an acre or so of land, it should be possible to have fresh fruit of some sort almost all the year round, to say nothing of the possible preserves from the fruits of judiciously selected species. The new or unknown always seems mysterious, but it does not require a deep or scientific knowledge of fruit-growing to grow a few fruit trees around the home; a little practical knowledge is desirable, but it

is chiefly a matter of common sense. As southern Florida has been so far chiefly a resort for the winter vacationist, it is only to be expected that the main horticultural advance should have been made with the more ornamental plants. Much professional effort has been expended in testing and growing them; there has been a steady demand for such plants, and a great deal of capital has been invested in the business of growing them. The less spectacular fruiting plants have not advanced so rapidly, and, although often used as ornamentals, they are still very much of an unknown quantity to the average gardener, while their economic uses are practically unknown to the average housekeeper.

Fruit is even more a necessity of the diet in hot climates, than in the temperate zone. Canned fruits soon become monotonous, and although fresh fruits are procurable from the North the greater part of the year, a certain amount of local produce is necessary in order to round out the menu. As these tropical and subtropical fruits become better known they will be more extensively used, in preference to cold-storage varieties from the North. The menu may be broadened and made more attractive and interesting through the use of preserves, pastes, and syrups; this in turn broadens the commercial outlook of this part of the country and at the same time makes home conditions more attractive, especially for children.

As landscape material, fruiting plants have as much value as many other plants grown only for flowers or foliage. Aside from their utility, there is a certain seasonal attractiveness about most of them which may be found in very few strictly ornamental plants; they lend a certain intangible character to a planting, as well as a wealth of interesting detail.

There is romance and geographical interest in the fruiting plants introduced from other countries. The mango from India, from earliest times a recipient of religious honors, comes to us through the early adventurous voyages of the Portuguese by way of Brazil. Later other varieties came from Indo-China and the Philippines, having come around the world by diverse routes to meet in our back yard. The avocado and sugar apple from Central America, the loquat from China and Japan, and the litchi and longan from China are fruits of great merit. From Mexico we have the sapodilla and the white sapote, while Africa gives us the kei apple, the ketembilla, and the carissa. The Cattley guava and the Surinam cherry are from Brazil, while the tamarind, one of the most useful of fruits, and the carambola, one of the most interesting, come to us from Asia. These fruits and many others have been for centuries part of the daily diet of the people in their countries of origin. The annatto, once used as war paint by the Indians of

Central America, is now employed in very much the same way by the modern woman in the form of lipstick.

Scattered throughout the lower part of Florida are numerous old specimens of many of these fruiting species. They have been producing fruit for a number of years, thereby proving their adaptability to the soil and to climatic conditions of this region. Much credit is due to the early homesteaders for their enterprise in giving the present generation these examples of acclimatized plants from warmer regions. These pioneers had their own daily problems of existence, but they looked well to the future when they planted such trees as the sapote, the sapodilla, the mango, and the avocado. Some of the early homesteads have been partially abandoned, and the trees have reproduced themselves, forming natural thickets, the seedlings growing up strong and vigorous where the original plant must have been carefully tended during its early years.

For a number of years, it has been a pleasure and inspiration on the part of the author, to visit these old places, learning, where possible, something of the history of the early settlers. As their descendants have prospered and are now absorbed into the daily life of the community, just so will the descendants of early introduced fruiting plants become absorbed into our daily economic life. Most of these early plantings are still in existence, a few of them are being cared for but most of them are neglected; and all are being casually taken for granted. Several of the old trees in these early plantings are worthy of protection as public monuments.

There is no dividing line between tropical and subtropical plants. There are distinct differences in hardiness between species of the same genus, for example the annonas, and between varieties of the same species, as in oranges, mangoes, and avocadoes. Local environment, as influenced by elevation, exposure, and humidity, is the controlling factor. The minimum temperature for tropical plants, as given by Wilson Popenoe in his "Manual of Tropical and Subtropical Fruits" is a good guide. He states that plants which do not thrive where the temperature frequently falls below 40° F. may be classed as tropical. While he does not give a minimum for the subtropical group, he states that it may be generally confined to the region of the date, the loquat, and the pomegranate. Atmospheric humidity, soil moisture, and the water percentage in the plant are other contributing influences. We have records of plants in West Palm Beach that passed safely through temperatures of 36° F., to suffer severely later on at 39° F.

While progress may be slow from year to year, much has been ac-

complished, and we now know enough about some of these plants to make bright promises for the future. Many under observation have passed through sufficient climatic changes to prove their adaptability. Several crops of fruit give indication of their individual merits, while the natural variations of type and quality found among seedling plants have given us a basis for selection of the better strains. Many additional species are under observation, and the next few years should yield interesting results.

Several years' observation of many introduced fruits, in different locations and under varying soil conditions, has given us a fairly adequate idea of their possibilities. Although much of the detail of cultural methods must still be worked out before large-scale orchard plantings can be undertaken with confidence, enough is now known about them to warrant small plantings for home use.

While much progress has been made in recent years, the future possibilities are unlimited. So far there are under observation in the various test plantings only a small percentage of the list of known species. The possibilities are vast, not only for those plants which may prove to be adaptable to our climatic conditions but for very many others, not of great value in themselves as producers, but as potential breeding material in the creation of more desirable types.

There are many borderline species which are not quite hardy enough to thrive, yet which recover after a setback from a cold spell. These may be helped by grafting on a hardy root-stock, or a suitable clone; or by hybridization with a hardy variety a resistant form may be developed. There is a decided necessity for further experimentation with these borderline plants, testing for suitable stocks, improvement in hardiness, fruiting qualities, etc. through hybridization and selection.

In compiling a list of plants for this book, it has been found impossible to draw a line between the strictly commercial and the curiosity or novelty fruits; the matter is purely one of individual taste. In the densely populated areas of the tropics, the twigs, leaves, and flowers of many trees and shrubs, purely ornamental with us, are articles of daily use in the diet. There is no reason why this should not be so; they have as much flavor and nutritive value as some of the vegetables for which we pay high prices in the market.

Some of the analyses quoted are incomplete and do not add up to 100%, while others add to more than 100%, these discrepancies being due to the methods employed in reporting and in totalling the figures, as in adding fiber, ash and acids. The author has accepted these as given and has made no attempt to correlate the figures, they

are included for whatever interest and guidance they may have to the reader. In each case the source of the analysis is mentioned.

The percentage of any food element assimilated through the digestive processes to repair the losses of the body constitutes the factor of assimilation; that is, the "Coefficient of Digestibility." Cardenas and Moreno state that their values were determined by means of artificial digestion after the methods of Kuhn in his "Principles of Agriculture."

CLIMATIC FACTORS

In his "Handbook of Climatology" Hann says: "What we mean by weather is the meteorological condition of a particular hour, day, month, year, or season of the year, while climate means the average of the weather experienced for a longer or shorter period of years."

Climate, according to Humboldt, indicates all changes in the atmosphere which sensibly affect our organs, such as temperature, humidity, variations in barometric pressure (conceded to be slight), and finally the degree of ordinary transparency and clearness of the sky, which is important not only with respect to the increased radiation from the earth, the organic development of plants, and the ripening of fruits, but also with reference to their influence on the feelings and mental condition of man.

Florida's climate is insular; proximity to the Gulf of Mexico and the Atlantic Ocean is one of the main factors in maintaining an equable climate. The waters of Lake Okeechobee have a beneficial influence on the southeast coast by tempering the cold winds from the north. The Gulf Stream, passing close to the east coast, has a decidedly ameliorating influence on the climate.

South of latitude 28° N. lies that section of Florida of interest to the grower of tropical fruits. Weather charts show the coastal area to be the best for this purpose, the east coast strip from Jupiter south being the most suitable as regards climatic conditions as a whole. This has been corroborated by the successful establishment of many exotic trees and plants over a period of many years. The coastal areas of Palm Beach, Broward, and Dade Counties on the east and of southern Hillsborough and northern Manatee Counties on the west show high annual rainfall and a high average immunity to frost. In the most favored parts of the state, however, the temperature sometimes descends to the thirties, and cold winds during the winter months injure the vegetation. These conditions should be taken into account and provision made for protection of young, tender plants. We must face actual facts in the development of a suitable listing of fruits for southern Florida.

The growing period has no definite seasonal limitations. One-half of the rainfall occurs from June through September. This is the period of rapid plant growth when a high average of temperature and humidity is experienced. November and December show a sharp decline in precipitation, with varying degrees of precipitation during the months from January to April; the month of May is variable but is generally characterized by fairly good precipitation.

Sometimes during the hot months of July and August a dry spell is experienced. This is the critical period for fruit trees, when most fruits are in process of development or are reaching maturity. Fog is rare on the southeast coast, occurring only a few days each year, then for a few hours at a time, and being dispersed early in the forenoon when the prevailing breeze from the Atlantic Ocean starts up.

The tropical storm is more of a bogey than is warranted by the facts. Southern Florida has fewer storms than many other parts of the United States. They are always possible during the late summer and autumn as tropical storms move northward, but are by no means of annual occurrence.

While frosts are to be expected at intervals during the winter months, freezing temperatures are rare in this area. Three or four cold spells are likely to occur each year, with penetrating winds from the northwest.

Florida has the sunniest winter climate in the eastern United States. The Florida peninsula not only has the highest percentage of possible sunshine but also, because of its latitude, the most intense sunlight of any lowland area east of Texas. The southeastern coastal area shows very little variation in atmospheric humidity, the percentage being fairly uniform throughout the year. The prevailing winds during the summer months from the east and southeast are fairly constant in direction and velocity. While the average atmospheric moisture throughout the year is high, the almost constant sea breeze relieves an otherwise oppressive condition, making the summer months pleasant and comfortable.

In "The Food Plants of the Philippines" Wester divides plants in the tropics into three groups: (1) those which succeed where the wet and dry seasons are marked and distinct, with a prolonged dry season of several months; (2) those which require a relatively high degree of atmospheric humidity and, if not an excessively large annual precipitation, at least a rainfall evenly distributed throughout the year with no long dry period; (3) those species which do not thrive at lower altitudes but, aside from other requirements, only succeed at high elevations.

Plants of the first two groups have a fair chance for success in southern Florida. Those of the third group have very little chance for successful development there. They may, however, be used for creating new types. The cherimoya (*Annona cherimolia*) is a good example. Growing in the high altitudes of Mexico and Central America, it has never succeeded near sea level. The sugar apple (*Annona squamosa*), a lowland species of the same genus, cross-pollinated with the cherimoya, has given us the atemoya, a hardy, prolific tree bearing fruit of a good quality. The atemoya has been growing in southern Florida for several years, and has proved to be thoroughly adaptable to the climatic conditions.

Soil moisture and the water table influence the winter dormancy of plants. Trees and shrubs that become dormant and shed their leaves in December in the deep, dry soils of Cuba, and do not break into leaf again until the April rains, may retain their leaves practically all winter in southern Florida, or at most have only a very short dormant spell. Where soil moisture is fairly constant because of a steady water table, periodic dormancy is greatly influenced by atmospheric temperature and moisture. Unlike many trees of the temperate zone, those of southern Florida make several growths a year. The growth tendency under the influence of the general climatic condition is steady throughout the year; this tendency is often checked in summer by a dry spell, and in the winter months by either a dry or a cold spell. As soon as these temporary influencing conditions have passed, and conditions have returned to normal, the trees break out in a new flush of growth. These growing and resting spells vary in time and duration according to fluctuations in the weather, the general climatic conditions being favorable for continuous growth.

Temperature changes with the changing seasons cause a corresponding slowing and quickening of the plant sap. Low temperatures in the temperate zone cause a slowing of growth and result in dormancy. In the tropics, where there is little difference in temperature between the summer and winter seasons; seasonal plant dormancy is caused more by seasonal moisture variations, the tropical dry season being the dormant season for plants. In the subtropical zone, in which southern Florida belongs, plant dormancy is caused partly by both, although the season is not so dry as in the tropics nor so cold as in the temperate zone. The practice of indiscriminate watering of fruiting trees and shrubs should be avoided during the dormant season. Fruiting plants should be allowed to become dormant and to remain so at this season; only evergreen trees bearing fruits at this time, such as the citrus, should be

given sufficient water to maintain the water content of the fruit. After the spring rains have started the plants into new growth, they should not be allowed to suffer, for lack of water, from the time growth first starts until they have matured their fruits.

A dry spell during the cooler months, if not too prolonged, is of advantage to most fruiting plants. The deciduous trees drop their leaves and go into a resting period, resuming a strong growth with the spring rains. The evergreen trees, especially citrus, which may be in fruit during that season, require some irrigation during a protracted dry spell. It is during the summer and early autumn months, when fruit is developing or in process of maturing, that a scarcity of water is dangerous. A decrease of water in the plant during the period of fruit setting will cause the fruit to drop, while the same conditions later in the summer, when the fruit is in the development stage, will cause the skin to become tough. A recommencement of the sap flow after this condition has set in will find the fruit unable to transpire water through lack of elasticity of the skin; the result is ruined fruit. The fruits of some plants, such as the mango and the avocado, drop off; those of others, like the citrus, split; many of the small bush fruits remain tough and mature prematurely, the result being a poorly developed, bitter fruit. In the event of a protracted dry spell, the water otherwise destined for the fruit is diverted to the leaves, to the detriment of the fruit.

The larger growing bushes or trees, with taproots penetrating well into the moist substratum, do not suffer so greatly during a dry spell. Nevertheless, most of the fibrous feed roots are close to the surface, and the lack of moisture causes damage. The smaller plants naturally suffer more readily, and must be given close attention and frequent irrigations during dry weather. The evergreen trees also require more attention to irrigation than do the deciduous ones. A good rule to follow under those conditions is to irrigate according to the amount of foliage on the tree. Water is just as vital as heat and light to plant life. It is essential to the structure of all living plant tissue, and there is a great difference among plants in the amount of water they require. During the hot summer months the transpiration from the leaves is heavy, thus creating a correspondingly heavy demand on the roots for replacement water in the plant tissue.

During the greater part of the year, the necessity for windbreaks may not be apparent. In the spring and summer months the winds are mild and, so far as personal comfort is concerned, very desirable. In the autumn months, from the latter part of September until well into November, there are apt to be strong, gusty winds from the east and

southeast. These winds are generally saltladen, and cause as much damage to foliage through burning from saltspray as they do through loss of fruit from the force of the wind.

The changeable wet-weather winds, coming frequently from the south and southwest, are seldom strong enough to make windbreaks necessary. The most harmful wind is that experienced during the winter months from the north and northwest. These cold, cutting winds, usually lasting two or three days, sear the foliage and leave the plants in a very dry condition, from which neither irrigation nor fertilizing will revive them speedily. Many of the plant cells will have been injured or killed outright on various parts of the plant. Recovery is a slow process of growth — dead leaves fall off and new leaves begin to grow. New cells are formed by the cambium at places where severe injury has occurred to other cells. Naturally young tender parts are far more susceptible to such injury than older, mature growths. If a second injury occurs before the plant has fully recovered from the first, the killing effects to the plant tissues are proportionally far more severe. A condition known as "bark-binding" may result from such injury, caused by a drying out of the cells in the bark and possibly by an actual killing of the bark tissue itself. The bark dries out and contracts around the trunk or limb. Because of such a constriction, particularly in thin-barked trees, the bark sometimes splits, and if injury has not been too severe, the movement of the sap may begin again. In other cases where "bark-binding" has occurred but the bark has not split, this constriction may seriously retard the flow of sap from the roots to those parts of the tree above the constriction. Below this point a large number of shoots from adventitious buds may appear, as mute evidence that sap flow has been materially retarded to the upper portions of the tree. In the northern United States, this same type of injury usually occurs on one side of the tree only due to "sunscald," but in the south it frequently occurs all around the trunk of tender barked trees usually being due to abnormally low temperatures. In the south, the most effective way of curing "bark-binding" is by slitting the bark of the constricted places on the trunk and main limbs, in order to release the circular pressure and allow the movement of sap within the uninjured ducts immediately underneath the injured bark tissue. The tops of injured trees should be pruned back or thinned out, and all dead wood should be cut out as it later appears for such wood is always subject to attack by diseases and insects. The tree should be given an application of fertilizer and irrigation. Even though it recovers its vigor, a year's growth has been lost. A good protection against the cold north and northwest wind is essen-

tial to successful fruit-tree development in southern Florida. In the average home yard, where windbreak plantings are not desirable, care should be taken to place the hardier and more wind-resistant trees and shrubs in the more exposed places, reserving the comparatively sheltered southern exposure for tender plants.

On the sandy coastal ridges and on the rocky lands of the southeast coast, there is no drainage problem. Sandy soils tend toward the development of numerous fibrous roots; these usually develop near the surface, where there is a greater percentage of decayed vegetable matter. This surface layer readily becomes overdry in a long dry spell, hence the advisability of mulching to help retain moisture in the surface soil. In the lowlands or "flatwoods," where the water table is relatively high and flooding is possible during the wet season, drainage is a necessity for all fruit-tree plantings. All living parts of plants require air, even the roots; in very wet soils the roots of normal plants become suffocated and fermentation sets in, causing the death of the plant. Swamp plants have special root adaptations for absorbing air, but the normal plant cannot withstand being flooded for more than a very short period, hence the necessity of supplying drainage when planting in low areas. The most efficient method of drainage worked out so far on flatwood lands is that of forming ridges running with the slope. These are made by plowing strips of land the desired width and throwing the soil toward the center of the strip, thus leaving a furrow between each strip. The ridges may be made higher and the furrows wider and deeper by a second plowing. The trees are planted along the ridges and on the slopes. Surplus water can thus readily run away from the plants into the furrows; from them it is led away in a main ditch. This system permits cultivation or mowing in any direction without interruption by ditches, and is thoroughly practical, even on an almost level ground. It has the advantage of being simple to develop and easy to maintain.

CULTURE NOTES

The southeastern coastal strip of Florida consists chiefly of sand overlying coral lime rock. In Palm Beach County, this sand layer is very irregular in depth owing to the irregular ridge formations; these are chiefly white sand and sand dunes. The surface is loose, with usually a thin layer of gray sand on the surface, caused by organic matter. The understrata consists of a light yellow sand, sometimes shading off to a dark brown or chocolate color, the darker formation being somewhat of a hard pan, but easy to break through with a shovel. Going south

through Broward County, a low area of marl soil is encountered, with the sandy ridge further inland. This is replaced in the southern part of the county by irregular rocky outcroppings, with sand in the higher levels and marl in the lower ones. As one proceeds into Dade County the formation is more uniform, with a thin layer of sand over coral lime rock. The southern part of the county is mainly coral rock of a jagged dogtooth formation, containing potholes of a fairly rich, sandy loam, with a strip of marl between the ridge and the ocean.

The sandy soil of the higher ridge areas is rather deficient in plant food. The marl areas require a good drainage system for the successful development of trees and shrubs. West of the rock-sand ridge, between it and the muck soils of the Everglades, lie the "flatwoods," poorly drained sandy-loam soils, usually quite acid. The acidity of these soils is more in the nature of a sourness, caused by lack of aëration; drainage and aëration will correct this condition. Some of the areas have become quite alkaline as a result of this treatment, and now require applications of manganese as a corrective.

The deep sandy ridges in Palm Beach and upper Broward Counties are low in organic matter, as well as in the essential plant nutrients. Soluble plant-food elements are readily leached through the sandy subsoil and lodged in the lower levels. On these areas shallow-rooted plants have a severe struggle for existence, while trees, after sending their taproots down into the moist, rich substrata, make a rapid, healthy growth and seldom suffer for lack of water. Analysis made by the Bureau of Soils of the United States Department of Agriculture show these sandy soils to be low in nitrogen, phosphate, and potash, the three primary elements of plant food. It is very evident, therefore, that special attention must be given to the problem of plant nourishment.

On the dogtooth rocky areas of southern Dade County, the shallow-rooting plants generally find nourishment in the plant-food concentrations of the potholes. Trees in this area are more inclined to be spready, unless in favored places of deeper openings; the roots find their downward progress restricted and are forced to spread out. Although the potholes and surface soils of this area are richer in plant-food elements, regular applications of chemical fertilizer are necessary for good growth and fruit production. In general, the soils of southeastern Florida are low in organic matter. This means that they are also low in microscopic plant and animal life. A system of cultivation that will increase the organic content of these soils is of the utmost importance. For field crops or commercial orchard plantings, cover crops may be planted.

For individual trees and bushes in the home yard, cover crops are not suitable; a quicker method of increasing fertility is required.

In planting, large holes may be excavated and filled with good soil or compost. After a few years' growth of the average tree or shrub the holes will be filled with roots. It is the period following this stage that must be taken into account in the culture process, when the roots extend into the surrounding soil in search of food. The deep-penetrating roots are merely water-seeking parts of the tree. There are two methods of increasing the organic content of the soil adjacent to the feeding roots: by mulching and by trenching. Mulching is the practice of covering the ground occupied by the roots with a thick layer of cut grass, leaves, or fine trash. Each year the coarser parts of the mulch should be raked aside and the fine, partly rotted material mixed into the soil with a digging-fork, the coarse material, with more added to it, being replaced on top; or the mulch may be left undisturbed and fresh material added each year as required. In trenching, a trench is dug around the tree, being extended farther out each year as the roots spread and filled in with compost. Either of these practices may be used to good advantage, or they may be combined. When mulch is used over the root area, a more uniform soil moisture and soil temperature is maintained. This is of great value to the tree, especially in dry, windy weather. Should the trench system be used, either with or without mulch, the looser compost soil must not be allowed to dry out in a long dry spell, as this is the place where the young feed roots will be found during the summer growing period. The trenching should be done during the more dormant period of the late winter months of February and March.

Mixing barnyard manure into the soil gives the quickest results in increasing the soil humus and fertility. Barnyard manure, however, is rather expensive for general use, besides not being available in sufficient quantity. Artificial farmyard manure is easily prepared from the grass cuttings, leaves, and other fine trash that are raked up and usually burned in the average home yard. Nature's own method of building up soil fertility is in the long run the best one to follow. It is available to anyone willing to expend the small amount of necessary effort.

It is surprising how much fertility is wasted in the average garden or home yard. Leaves, grass clippings, and weeds, usually thrown away or burned, should be composted for future use. Such a compost, well rotted, is the best all-round material for digging into flower or vegetable beds or placing in holes for planting trees or shrubs. It is rich in the organic matter and bacterial life so greatly needed in sandy soils. It is

also rich in plant foods in well-balanced proportions. There is always an off corner where a compost pile or pit may be made. A loose pile is very unsatisfactory; a pit or boxed space is preferable. The trash should be spread in layers of four to six inches and well compacted. A thin layer of soil or sand spread over each layer of trash will be found beneficial. Filtering through the trash, it fills in the spaces and helps to eliminate air pockets. The material should be kept well trampled and damp so as to avoid heating. Two small deposits in place of one large one will be found to be more practicable, the one being used while the other is being built up; a year is the approximate time required for thorough decomposition. In the case of one large deposit, it should be worked over each year, the fine decomposed material being taken out for use while the coarse parts are left for further action. For large deposits, the addition of certain inorganic materials such as nitrates, phosphates, lime, etc., may be used to hasten the process of decomposition, and to increase the fertilizer value of the compost.

Coarse, undecomposed trash buried in the soil near the roots of plants will cause more immediate harm than benefit for two reasons. First, it tends to keep the soil open, thus making it more subject to excessive drying. Second, the bacteria active in breaking down the undecomposed matter require a certain amount of quickly available nitrogen as food while active. As this is taken from the surrounding soil, a deficiency of available nitrogen results, to the detriment of the plants. The nitrogen used by the bacteria is later released to the soil again, but a serious deficiency is apt to result for the time being.

Rough vegetable material is more readily and effectively broken down to the desired condition when composted, especially where a little help is given to stimulate the natural activity of the bacteria. The material must be kept moist, as this condition is vital to the continued activity of the bacteria. It should be well compacted so as to exclude possible air pockets; should the material be dry or loose, it will heat and be wasted. It is recommended that the material be composted in a shallow pit if possible. A mixture of the following inorganic materials has given good results: 45 pounds of ammonium sulfate, 20 pounds of superphosphate, and 35 pounds of ground limestone to 2000 pounds of dry composting material. Mix only the amount to be used in one day. A foundation of trash about a foot deep should be laid in the bottom of the pit and trampled thoroughly. After sprinkling well with water, a proportionate amount of the chemical mixture should be spread on top and lightly sprinkled. The stack is now built, with layers of trash six to eight inches thick, well trampled and moistened, the

second layer is now dressed with the chemical material and again lightly sprinkled. For two or three days after completion the pile should be trampled and lightly sprinkled, and then covered with sand or thatch. Should it appear to heat it should be well trampled again and thoroughly wet. The pile should be turned over at the end of six months, each layer being sprinkled and compacted as it is turned. By the end of another six months the pile should be ready for use. When this is well done the result is almost identical in form and fertilizer value with that achieved by farmyard manure. Another mixture that may be used to good advantage in composting is as follows: 30 of ammonium sulfate, 12 of potassium chloride, 25 of calcium carbonate and 16 of superphosphate to 1000 pounds of dry material.

While the greater need of southern Florida soils is for organic matter, chemical or inorganic fertilizers are also very necessary for the successful development of all crops. They are a source of quickly available plant food, and are easily combined to supply the plant requirements at various stages of development. They are as vital to fruit-tree development as to vegetable-growing. A light dressing of quickly available nitrogen just before the flowering time will work wonders on fruiting trees and shrubs.

For these alkaline sandy soils the familiar combination of nitrogen, phosphate, and potash is not enough. While the soils are deficient in the three primary plant food elements, they are also found to be deficient in other elements, known as secondary or amending ones, such as manganese, copper, and sulphur, a deficiency of which inhibits normal plant development. In the last few years much has been discovered concerning the use of these lesser-known elements as correctives in cases of stunted growth and general plant debility.

The soil of southern Florida, on the average, is not a soil for optimum plant growth. As a result newly planted trees and shrubs require much care, and must be supplied with the essentials for good development for the first year or two. After a tree or shrub has become established it can fend for itself to a large extent. Holes of a suitable size should be opened and filled with a good compost at the time of planting. On deep sandy soils a preponderance of heavy clays in the planting mixture should be avoided; a light compost mixture will be found more satisfactory. Water drains off quickly leaving the heavy clay mixture hard and dry, and this mixture will not absorb moisture from the surrounding soil.

It is not advisable to mix readily soluble inorganic fertilizers with the compost at the time of planting. Newly set out plants require frequent

irrigations until established, and there is an abundant seepage in which the readily soluble elements are carried off. Organic manures or fertilizing materials, such as blood, bone meal and cottonseed meal, may be mixed with the planting compost. After the plant has become established, an application of quickly available inorganic fertilizer may be in order. This should be worked into the surface of the soil with a hoe or rake.

In planting fruit trees and bushes in home grounds, regular spacing should be avoided. Where only one or two of a size or type of growth are to be planted, some thought must be given to the spacing and general landscape effect. The trees should be given space for full development, while the shrubs may be planted singly or in groups, some of them in conjunction with one or two trees where they can have partial shade. Some tropical fruiting shrubs require a certain amount of shade, while others require full sunlight for good development.

Small plants set out in the spring or early summer months should be shaded until they become established. A palm leaf or branch cut from a tree will be sufficient to give partial shade during the hottest part of the day. Plants grown in pots, boxes, or tubs do not require defoliating on planting. They may, however, have been grown in a lath shed and thus have become accustomed to partial shade. Small trees and bushes dug from the open nursery field, even with a good ball of earth on the roots, should be pruned back slightly or partially defoliated. Partial shade for a few weeks is always advisable for newly placed plants.

Mulching the ground around plants is always a good procedure when they are young. After they have attained sufficient size to shade the ground over the root area, mulching may be dispensed with in the home yard, although it is always best to use mulch wherever possible.

The most readily available mulching material is cut grass or leaves raked up from the yard. A grass mulch in order to be effective must be fairly thick, and since this mass of material is often very dry there is always danger of fire during long, hot dry spells. Sawdust or plan-ings from a woodworking mill make a very satisfactory mulch, neat in appearance for the home yard and not readily combustible. An inch or slightly more of this material is sufficient depth. Sawdust has been blamed for harboring wood borers, but it does not do so any more than do other mulching materials.

The proper pruning of evergreen tropical and subtropical trees and bushes is quite different from that of deciduous fruiting trees of the temperate zone. For the latter, the pruning is light, and should be

confined chiefly to shaping the trees and eliminating overcrowding sucker growths in the tops. All fruit trees require some pruning, the quick-growing softwood types requiring more than the slow-growing hardwood ones. An open growth and a uniform shape are essential to good fruiting form, making pruning to some extent a necessity.

Heavy pruning of trees and bushes at fruiting time should be avoided unless the aim be the renovation of old or storm-damaged trees. It stimulates strong vegetative growth to the detriment of fruiting. Heavy pruning is better done in the late winter months before spring growth has set in; it should never be done while growth is very active.

Water sprouts or suckers should be removed from the tops, since the fruiting growth, especially among the citrus trees, is confined to the slow-growing finer twigs. Pruning is an operation by which the growth and fruiting of trees and bushes may be controlled. It is a possible method of regulating the balance between vegetative and reproductive growth.

Most tropical and subtropical trees have an excessive amount of secondary branches and shoots, forming too dense a top. The same tendency exists in bushes. Such crowding is detrimental to healthy growth and to the production of good-quality fruit. In such cases, pruning is simply a thinning-out process whereby the less desirable branches and shoots are eliminated to the advantage of the more desirable fruiting ones, so that the latter may produce larger and better fruits.

There are no set rules for pruning. The amount to be done depends on the peculiarities of growth of the tree or bush in question and the immediate results desired. Annual pruning for fruit production is essentially a light thinning-out process, while the renovation of worn-out or neglected trees requires heavy pruning, an operation necessary only once in several years. The location of the fruiting buds should be understood before pruning operations are carried out on any fruit tree. When any large amount of pruning is to be done, it is better to employ the services of someone experienced in this work, or at least to ask his advice; for much harm can be done through improper pruning.

A dense top may be desirable in an ornamental shade tree but is very undesirable in a fruiting tree, which thus wastes much of its vitality on vegetative growth instead of using it for reproductive growth. The top should be thinned by cutting out the weaker-growing branches that fill its center, thus leaving the main limbs with their lateral branches to form a half-shady canopy through which air and sunlight may penetrate. There is, of course, danger of too much thinning the result being sun-

scalded branches; but there is nothing very difficult about the operation, provided a little thought is given to it. All weak or diseased branches and all dead growths should be removed, a sharp instrument being employed in order to make clean cuts. Cuts over an inch in diameter should be painted. Ordinary paint will suffice, but prepared tree dressings are more satisfactory. When the branch grows from the trunk or a main limb, it should be cut as close as possible to the latter in order to avoid leaving a stub.

PLANT DISEASES

Plant diseases are so common that it would be practically impossible to find any group in which some disease, however unimportant, does not occur. Under ordinary circumstances, the damage caused is slight and not readily noticeable to the casual observer. Only when it has become serious enough to be detrimental to the welfare of the plant is it considered important enough to take the necessary steps to keep it under control.

While much progress has been made in the study of plant diseases in the temperate zone, very little systematic study has been done on the diseases of tropical plants. The tropical zones of the eastern and western hemispheres each have their peculiar problems. Local climatic conditions have a great influence on the prevalence of certain diseases and any condition that upsets the natural balance between water and food available, temperature, light, and growth has an influence. It has been noticeable that during the spring and summer following a hurricane, aphids and other insects, usually kept in check by birds, are more prevalent. A hot, wet summer is conducive to more fungoid and bacterial diseases, while scale is not so prevalent as in dry weather.

Much work has been done during the past few years on plant diseases in general, but sometimes the actual destructive disease is secondary to some other condition, such as shock or malnutrition. Interested persons should keep in touch with the publications of the Agricultural Experiment Stations which are equipped to give competent advice. Local spraying specialists are usually competent to take care of the home-owner's troubles.

The term "plant diseases," as generally understood, is a misnomer. Insects which attack the plant, eating the leaves, boring into the bark and wood, or sucking sap from the leaves, are not truly diseases; neither are fungi and bacteria, although they may weaken the plant sufficiently to make it susceptible to disease. The insects, fungi, and bacteria are

theoretically causative agents, but it is these agents that have to be combated.

In earlier times, plant afflictions and pests were classed in three groups: (1) insects, chewing and sucking; (2) scale, although scale is really a sucking insect; and (3) fungi. All others were dismissed as vagaries of nature. Today, through the advancement in the study of the causes of plant diseases, we have a more detailed list: fungi, bacteria, infective viruses, nematodes, sucking and chewing insects, and non-parasitic diseases.

Fungi are vegetable growths of a simple kind. They range from simple yeast forms up to the many-celled mushroom or toadstools and the flat, leathery forms seen on dead tree-trunks. While most fungi feed on decaying matter, some have become adapted to feeding on living tissue, and given the right conditions, any part of the plant may be attacked — leaves, flowers, fruit, stems, or roots. Copper salts or sulfur generally in combination with lime, are the chief materials used to combat fungous growths.

Bacteria are minute, typically unicellular organisms, attacking chiefly the storage tissue of plants or young developing shoots. They enter the plant tissue through wounds, and are often found in conjunction with fungous infestation. They are often carried by insects which puncture the young plant tissues.

Infective viruses are conceived as depending upon an infective principle of unknown nature, recognized only by the effect it produces. They affect all parts of the plant, entering the tissue through wounds, however slight, and are transmitted to healthy plants from diseased ones by handling or, most commonly, through the agency of insects. The virus diseases affect chiefly the field crops, tobacco, potato, cotton, etc. Sugar cane has been severely affected by the mosaic virus transmitted by aphids. There is no cure for this disease. Some varieties of the plants attacked may be very susceptible or may have a high tolerance for the disease, others are resistant, while still others are virtually immune. The control lies in the breeding of resistant or immune varieties.

Phanerogamic parasites, or parasitic flowering plants, are not so prevalent in southern Florida as in the West Indian islands. The love vine (*Cuscuta americana*) may be seen on trees and shrubbery in neglected areas. Complete eradication is practically impossible under present conditions, although the parasites may be easily kept under control in cultivated areas. Mistletoe, or bird vine, of which there are many species, is very rare in southern Florida, which appears to be in an isolated area between zones infested with the American species of

Phoradendron and those infested with the West Indian species of *Loranthus*.

Nematodes (eelworms) are worms of simple structure hatched from eggs. They have a larval and a mature stage, and are not, as is sometimes supposed, the larvae of some insect; they are true worms. The order contains a large number of species which live in soil or in water or on decaying vegetable or animal matter, and others which are parasitic to various degrees. The nematode parasitic on plants is typically minute and almost invisible to the naked eye. Most of our fruiting trees and bushes are not seriously affected by attacks from nematodes. In some cases, desirable species which are susceptible to them may be grafted onto non-susceptible root-stocks. This method has proved to be satisfactory in the case of the fig and the Barbados cherry.

In "Diseases of Crop Plants in the Lesser Antilles," Nowell divides the injurious relationships of insects to plants as follows: (1) direct injuries in the nature of wounds; (2) systematic or organic disturbances originated by sucking insects; (3) exposure of internal tissues to infection; and (4) transference of infection.

Direct injuries to the plant tissue caused by biting or boring insects have an influence on the well-being of the plant. Derangement of normal function is thus readily caused by insects on the leaves and twigs. An attack on the leaves by red spiders often causes serious defoliation, thus checking the normal activity of the plant growth. If this occurs during the fruiting period, a severe loss is likely to result.

Sucking insects in many cases cause a poisoning of the plant sap through toxins injected on puncturing the soft tissue. Chlorosis or yellowing of succulent vegetables following an attack by aphids is due to toxins thus injected.

Any wound or opening in the protective tissue of leaves or twigs, however minute, is a point of attack by fungi. An attack by sucking or biting insects may readily be followed by one of fungoid or bacterial disease. Fungoid diseases of leaves or fruit are often transmitted through this agency.

Insects are very effective carriers of plant diseases in their migrations from tree to tree or from one locality to another. Fungoid or bacterial organisms injurious to plants have been found on their bodies. The insects themselves are not injurious.

Some virus diseases pass through an incubation period in the blood of certain insects. The mosaic diseases of tobacco and sugar cane are transmitted through the bite of aphids, just as malaria is transmitted through the bite of the *Anopheles* mosquito. It has been demonstrated

that the curly-top disease of beets, transmitted by a Jassid bug, requires an incubation period of twenty-four hours in the body of the insect.

Healthy, vigorous trees and shrubs in favorable locations are not so readily attacked by aphids as are sickly ones in unfavorable locations. Clean tilth and open, airy growth will do much to induce conditions unfavorable to insect attacks.

Sucking insects are not readily poisoned. A contact spray, generally with a pyrethrum base, or a nicotine spray, which affects the respiratory apparatus, is usually effective. Chewing insects are easily combated with stomach poisons, mostly with an arsenic base. Scale insects, owing to their shell-like protective covering, are not affected by contact sprays except in the very young stage. Soap or oil emulsion sprays, which form a suffocating covering, are the most effective means of combating them. Borers cannot be adequately reached by spray materials. Poison gases in liquid or powder form should be injected into the holes, which should immediately be sealed with wax or clay.

Physiological "upsets" are caused through maladjustment between the plant and its environment. Unfavorable soil, unsuitable exposure, deficiency of water, or deficiency of necessary mineral elements in the soil may cause sap stagnation or an unbalance of sap elements and finally dieback of the young twigs. A tree in such a condition is particularly susceptible to attack by insects, fungi, or bacteria. While its ultimate death may have been caused by these diseases, they are only secondary, the primary cause being physiological upset. The trouble must be attacked at its source and the maladjustment corrected before it is too late.

PRESERVES, JAMS, JELLIES AND PASTES

When one stops to consider how many different fruits there are in southern Florida, and their suitability for making all sorts of preserves, one is truly amazed. This is a comparatively new country, horticulturally speaking, and these fruits have been coming in gradually and in a more or less scattered and disorganized manner. Only a lack of general knowledge of them has kept them in the background. Many of the fruits and preserves made from them, unknown to the general public, are in daily use in the homes of the earlier settlers in the country districts. Even so, the possibilities of the use of these fruits in the form of preserves, syrups, relishes, spices, and crystallized products are very little understood.

With modern equipment, fruit analysis, and the results of laboratory tests and experiments to guide us, guesswork has largely been eliminated

from preserving. Even with a fruit new to us, there is no blind groping through trial and failure in order to find out what can be done with it. Cooking two or three of the fruits for a short time and testing them for pectin and acid will quickly determine whether or not the new fruit is suitable for jelly-making. If it is not suitable for jelly, it may prove to be good material for jam or for fruit butter, as with most of the fleshy fruits, while some of the acid fruits of high water content make excellent syrups and wines. The sapotaceous fruits do not lend themselves to jelly-making. The sapodilla, especially, cannot be considered a cooking fruit; efforts to make preserves from this fruit will result in a mess of rubber.

Practically all fruits may be canned, this being the field of preserving in which most progress has been made in recent years. In jelly-making, the theoretical finishing-point is reached at 221° F. but different fruits vary considerably; some reach the jelling stage at 218° F., while with others a temperature of 222° or even 223° F. is needed for a firm jell. It is evident that the thermometer should not be relied upon alone with new fruits; the spoon test should also be used. After the peculiarities of the fruit have been noted, the latter may be omitted.

Most tropical fruits lose their pectin content rapidly on maturing, this usually being at its height when the fruit has reached full size and is beginning to color. The sea grape is an exception, and must be fully ripe in order to jell. Citrus may be used when fully ripe, while the pineapple has practically no pectin content at any stage of development. Jellies or pastes made from some of the highly acid fruits, such as the cape gooseberry, the tamarind, and the caranda, are ideal for serving with meat or fish, but are over-acid for ordinary table use. Carissa makes a jelly suitable for both purposes. The high-acid, low-pectin fruits should be cooked with an equal portion of full-grown green papaya fruit, so as to reduce the acid content and increase the pectin. The papaya should be ground fine before cooking, and requires long, slow cooking for good results.

Commercial pectin has greatly facilitated jelly-making for home use. It has not only eliminated the chances of failure but has made possible a more fully-flavored product. Fruits when ripe have a richer flavor than when at the optimum pectin stage of partial ripeness. The addition of commercial pectin makes possible jelly-making with ripe fruit.

Marked progress has been made in the last few years in the development of canning equipment for home use, and while "canning in tin" may be a more suitable method for quantity production, it seems a very impersonal method for the kitchen. For home preserving, the glass jar

seems to have a more intimate and satisfactory appearance. It is a pleasure and a satisfaction to see the result of one's efforts neatly arrayed on the shelf, and to recognize each one for what it is.

While fruit syrups are not in such general household use as are jams and jellies, there is a place for them in the menu. The tamarind, one of the most useful of tropical fruits, makes an ideal syrup for use with waffles, griddle cakes, or puddings. It also has merit as a stock for cold summer drinks. Fruit syrups are useful in desserts, and as flavoring in ices and in gelatins.

Even with strange fruits, jam-making is a comparatively simple operation. With many of these a good jam may be made from the pulp, after straining off the juice for jelly.

Fruit pastes or butters are always desirable additions to the menu. Some fruits lend themselves admirably to this purpose; the paste or butter may be made either in the first cooking process or from the fruit pulp after straining off the juice. Such preparations are useful in baking, as an ingredient in loaf cakes, in soft icings, and as a fruit base in making ice cream or pudding.

As orange marmalade and guava jelly have become favorites, even so is it possible for many other fruits to become popular. Some, although not commercially known, are favorite items in the menu of older residents. Most of them make excellent jellies; some, like the carissa and the ketembilla (*Dovyalis hebecarpa*) furnish jellies to be served with meat or fish; others are simply table jellies. A few fruits give better results as jams or in compotes, and many are satisfactory in the making of syrup, like the tamarind and Surinam cherry.

In low-acid fruits, it is a common custom to add lemon or lime juice when making jelly. The citrus flavor is generally quite overpowering, and in many cases the flavor of the basic fruit is lost. A small amount of tartaric acid, added to the fruit while cooking, will supply the necessary acid without affecting the character of even mild-flavored fruits. It also adds sprightliness to the jelly.

Jams are so often considered as simply fruit pulp cooked with sugar to a stiff consistency. To be properly made jams should show a jelly-like appearance, this appearance is due to the presence of pectin, the gelatinous substance in fruits essential to the making of jams and jellies.

Fruit preserves in general should be cooked over a rapid fire as slow cooking causes a loss of flavor and a darkening in color.

In making jams small fruits may be used whole, the larger fruits being sliced or cubed. In selecting fruits for jam some may be fully ripe but at least half of them should be underripe, as the ripe fruits break

down to form the clear syrup and to impart flavor while the underripe ones remain whole and supply the pectin content. The finished product therefore should have pieces of fruit suspended in a clear jelly the whole having a firm jelly-like consistency.

After the fruit has been prepared for cooking an equal amount of sugar by weight is added. As rapid cooking is essential to the preservation of the flavor constant stirring is necessary to prevent scorching. If a thermometer is used the temperature should be raised to the same point as in jelly making, 221° to 222° F. In testing with the spoon clear juice should be dipped out and tested as for jellies, the finishing point being reached when the juice "sheets" off the edge of the spoon instead of dripping off.

Fruit jelly is the finished product of cooking fruit juices and sugar together. Jelly, however, only results under certain circumstances; there must be a proper proportion of fruit juice and sugar and the juice must contain the right amount of acid and pectin.

Pectin is the gelatinous-like substance present in varying amounts in fruits; some fruits like the apple and the Santo Domingo mammea have a high pectin content while others like the pineapple have practically none. Fully grown partly ripe fruits contain a higher percentage of pectin than do fully ripe ones. As the fruit matures the pectin gums are broken down into other elements in the chemical composition of the fruit. Without a sufficient amount of pectin in the clear juice, after cooking and straining, it will not jell, and without a sufficient amount of acid in the fruit during the cooking process the pectin in the fruit will not be released from the pulp to the juice.

Under factory control the acidity would be tested by special apparatus designed for this purpose, the optimum acidity for jelling being pH 3.5–4. For kitchen operations litmus paper may be used but a good acid taste is usually a sufficient indication. The pectin content may be measured by putting a teaspoonful of juice in a small glass with an equal amount of grain alcohol to coagulate the pectin. A stiff lump of gelatinous-like substance denotes a high pectin content while a loose or broken formation denotes a low pectin content. These tests should be made after the fruit has cooked long enough to be fairly well broken down.

With a juice of sufficient acidity and a medium pectin content the juice may be concentrated to the desired pectin content by further boiling after straining, a low pectin juice should have prepared pectin added.

With a good pectin content an equal measure of sugar may be added to the juice which is then boiled vigorously to the "finishing point" of

"sheeting" from the spoon or to 211° to 222° F. by the jelly thermometer.

In making marmalades small fruit may be cooked whole while the larger ones should be thinly sliced. Marmalade, when properly made, shows small pieces of the fruit throughout the mixture which is fairly stiff and smooth in consistency.

In the citrus fruits the juices contain very little pectin while the white spongy inner skin has a large amount. Some people prefer to use the "three day method" of heating, standing and reheating to release the pectin but the finished product is no better in quality than that made in a few hours. To prevent the particles of fruit from rising to the surface the marmalade should be allowed to cool somewhat before pouring into jars.

Fruit juices can be used in many ways in the home especially in planning deserts. For making juices it is advisable to select well ripened fruits in order to get the full flavor without the higher acidity of the partly ripe ones. Overripe fruit, however, impart a disagreeable taste to the juice and may cause spoilage.

For small quantities for home use the fruit may be crushed by one of several methods — by passing through a fruit grinder with a strainer on the bottom for the juices, or by twisting the fruit mass in a strong cloth or in a small screw press with a spout for juice. These methods are known as the "cold process" of extraction. In the "hot process" of extraction the fruit is heated before pressing. This method is supposed to give greater yields of juice, but for all practical purposes in the home kitchen one of the cold process methods will suffice.

The clear strained juice is then heated to from 170° to 190° F. for five minutes for sterilizing. Boiling spoils the flavor of the juice so that it should not be allowed to reach even to 200° F. If a thermometer is not available the juice may be heated in a double boiler and allowed to steam or simmer for five minutes.

For home use it may be easier to make a fruit syrup. The process of extraction is the same as for the juice. After the juice has been strained two parts of sugar to one of juice is added and the mixture is heated sufficiently to thoroughly dissolve the sugar and to sterilize the juice, after which it may be bottled and corked.

Fruit pastes are handy for use in baking and may be used in several ways in fillings and in icings. For small quantities in the home a good paste may be made from the fruit pulp left over after extracting the juice for jelly. The pulp is worked through a sieve to remove the seeds and skins. Then to the cleaned pulp is added an equal amount of sugar by weight. The mixture is then cooked over a slow fire with

steady stirrings to prevent scorching, or in a double boiler, until it begins to thicken. When boiled down as much as possible the mass is spread in shallow pans or on a sheet of glass or wax paper and allowed to dry for several days. It is then cubed and rolled in sugar and allowed to dry for several days more before packing in jars. A soft paste, needing very little drying, may be packed in screw topped jars, in this form it is ready for quick use.

DESCRIPTIVE LIST

ANACARDIACEAE

The Anacardiaceae family includes, among others, several genera of tropical and subtropical economic plants, the most important being *Mangifera, Anacardium,* and *Pistacia.* Other genera of lesser economic importance at present include *Bouea, Harpephyllum,* several species of *Spondias, Dracontomelon,* and *Semecarpus.* With the advancement of plant-breeding and scientific horticulture throughout the tropics, there is no reason why some of the species in the latter group should not some day be developed into fruits of economic importance. In the present discussion we can only concern ourselves with the fruits which are of use in the home menu.

A characteristic of the Anacardiaceae is a resinous bark. Many trees of this family yield gums of value for medicine and varnish. There are about sixty genera, occurring mostly in the warmer zones of both hemispheres. To it also belong poison ivy and poison sumach.

Anacardium occidentale

The cashew (*Anacardium occidentale*) is indigenous to the West Indies, Central America, Peru, and Brazil. It has been naturalized in Africa, India, and the Malay Archipelago, whence large quantities of the nuts are shipped to Europe and the United States. The tree is of medium size and has an open style of growth. The leaves are entire, ovoid, prominently veined, and from four to eight inches in length. The flowers are small, usually dull red or pink in color, and are borne in loose panicles. The fruit is very showy, there being two distinct colors, clear lemon yellow and bright red; although there is quite a noticeable difference between the two in flavor and they do not hybridize, no botanical distinction has been made between them. In Cuba they are known as Marañon rosado and Marañon amarillo.

In southern Florida the cashew has fruited well. There are several fairly large trees bearing good crops of fruit each year. When young

the plants are very tender, and should be protected during the winter season until they have developed a woody growth. The tree begins to bear when four or five years old, the fruit ripening in March or April.

The cashew will grow in almost any well-drained soil in a warm climate, and is tolerant of drought. It is propagated from seed, but may also be reproduced from cuttings or by marcottage. It reaches a height of thirty feet or more in favorable situations in the tropics. In Florida its full height seldom reaches over fifteen feet, with a spreading growth. It is naturally sprawly, and can be shaped to better advantage by pruning. This, however, should be the only reason for pruning as the tree apparently prefers to be unmolested and pruning for fruit is not necessary.

The gum which exudes from the trunk, called kaju gum makes an excellent mucilage; as it is repellent to insects, it is valuable in protecting books, pictures, etc. from ants and other destructive insects. The bark is used in tanning, while the wood, which is very strong, is used in carpentry.

It can hardly be said that the cashew is cultivated. In the West Indies it is extensively planted, principally for fenceposts, and grows readily without care. Extensive growths occur in northeastern Brazil, the fruits being in good demand in the market cities. Although the cashew grows fairly well on poor, dry soils, it responds readily to fertilization and irrigation, the fruits so produced being much larger and of better flavor.

The so-called fruit is the enlarged fleshy pedicel. It is very juicy and brilliant red or clear lemon yellow, with a piquant aromatic aroma. The large, brown seed, the true fruit, closely resembling a boxing-glove in shape, is at the end of the very much enlarged fleshy and juicy pedicel. The rich kernel is considered of better flavor than any other nut in the world, and is very rich in oil. It is used chiefly as a table nut and in confectionery, and commands a high price. The rough shell contains an acrid, caustic oil which is poisonous but which is readily destroyed by heat. This is done in a crude way by the natives, wherever the cashew grows, by putting the seeds in hot coals or ashes and cracking them when well toasted. The juice of the fleshy part of the fruit (really the pedical) is sparkling, refreshing, and slightly astringent. It is commonly employed as an ingredient for "ades," the flavor being very pleasant and refreshing. Preserves made from the fruit have a distinctive and very attractive taste.

Perhaps none of the tropical fruits make such a delightful wine as

does the cashew. A fermented liquor, extremely intoxicating, called kaju is made from this fruit and bottled for the market. The ripe, fleshy fruit makes good pie material and preserves. The nuts should be well-roasted, shelled, and rinsed in boiling water before eating.

Analysis made in Hawaii shows the following percentages: Fruit — protein, 0.71; sugars, 10.40; acidity, 0.55. Nuts — protein, 14.44; fats 41.57.

Analysis made in Cuba shows the following percentages: Fruit — water, 86.67; protein, 0.26; fats, 0.37; sugars, 6.70; carbohydrates, 2.00; fiber, 3.10; tannic acid, 0.50; ash, 0.40.

Coefficient of digestibility: Protein, 80.00; fats, 96.00; carbohydrates, 90.00.

In the Dutch East Indies, the nuts are toasted to remove the shell, and the kernels are used in the preparation of a side dish, to be eaten in conjunction with the main rice dish. The fruit is eaten raw with salt and is employed to make "roodjak," prepared with sugar, chili, and water. It is also pickled with salt and a weak solution of vinegar.

The cashew tree is fairly free from disease in southern Florida; the young, tender leaves are often attacked by thrip, while the fruit fly sometimes injures the ripening fruit.

Mention has been made of the poison in the seed covering. There is not the slightest danger in handling the seeds unless the skin is broken to release the oil, which causes a cutaneous irritation, analogous to that caused by poison ivy, varying in intensity with different people.

Anacardium excelsum, from Central America, is a stronger-growing species, its chief value being as a timber tree. It grows well in Cuba but has not been known to set fruit there.

Spondias

The species of the genus *Spondias,* although widely scattered throughout the warmer parts of the world, are of little commercial importance. Among the natives of the tropics, the fruits and young leaves are used in various ways. The species cannot, however, be strongly recommended as fruiting trees for home-planting purposes in southern Florida.

There are many local variations or types of the different species of *Spondias*. The fruits range in color from light yellow to dark red. Their size varies considerably, while the flavor ranges from mildly sweet to acid. These types have possibilities for breeding, and should, in the hands of a plant-breeder, become of economic value. They are prolific bearers, but improvements are desirable in the form of smaller seeds, larger fruits, and a higher percentage of pulp.

Of the species planted in test gardens, the imbu (*Spondias tuberosa*), from northern Brazil, is the most promising. It is considered by some authorities as the best of the species of *Spondias,* but so far has not been successfully grown in Florida. Further tests are necessary in regard to soil adaptability and possible root stocks.

Spondias cytherea

The ambarella (*Spondias cytherea*) from Polynesia, there known as vi, is a rapidly growing tree with large pinnate leaves. The fruit is plum-shaped, about the size of a hen's egg, and is the largest in the genus. When ripe it is of an amber color, the flesh being brownish yellow, of a spicy, acid-sweet flavor, enclosing a very large seed. The spiny nature of the seed is an objectionable feature and is the chief drawback to the popularity of the fruit.

The juice from the ripe fruit makes a very pleasant drink. The latter may be used for sauces and jams, the green fruit being made into jellies.

Analysis by Wester and Valenzuela from the Philippine Islands shows the following percentages: Total solids, 40.35; moisture, 59.65; protein, 0.80; fat, 1.79; sucrose, 8.05; crude fiber, 3.60; ash, 0.65. Calories per 100 gm.: 157.30.

This species appears to be quite adaptable to conditions in southern Florida. It is not very well known and has not been widely planted. Several trees in lower Dade County have fruited well.

Spondias mombin

The yellow mombin, jobo (*Spondias mombin*), or hog plum (*S. lutea*), is indigenous to tropical America and rather common from Mexico to Brazil, and has been one of the common fruits of the aborigines throughout these regions. Since it grows spontaneously and in varied locations and soil conditions, there is naturally a great variation in the size and quality of its fruit, but so far there is no record of superior varieties having been propagated commercially.

The fruit is oval, slightly over an inch in length, and light yellow. The soft pulp is juicy, mildly acid, and generally with a slight flavor of turpentine. The fully grown green fruits make a spicy jelly.

The yellow mombin forms a tall tree, and although it grows rapidly and is of much use throughout the tropics, its quality does not warrant its being planted here to any great extent where so many other more useful fruits are available. It should, however, be included in experimental plantings for possible breeding experiments.

Analysis from the Hawaii Agriculture Experiment Station's annual report for 1914 shows the following percentages: Waste, 52.50; water 88.53; ash, 0.65; fiber, 1.16; protein, 1.37; fat, 0.56; sugar, 9.41; acid, 0.98.

Calories per kilo of food: 481.

Spondias purpurea

The Spanish plum or red mombin (*Spondias purpurea*) is indigenous to tropical America, but is not so widespread as the yellow mombin. It is grown to some extent in the West Indies; in Cuba it is found chiefly in fencerows, where branches three inches in diameter and up are planted as live posts.

In general the fruit of the red mombin is superior to that of the yellow mombin, being larger and with a better flavor. The color varies from yellow to red; the flavor also varies considerably. The tree does not grow tall, having a spreading crown distinct from that of the yellow mombin.

The red mombin has not been given a very extensive trial in Florida, and the few trials made so far have not been very successful. The growth is quite tender and the young plants suffer severely in cold spells. Should superior varieties be produced, the tree would merit cultivation, but at present it is not recommended for planting outside of experimental orchards. The fully grown green fruit is used for jellies, while syrups and wine are made from the ripe fruit. A spicy drink may be made from the fully ripe fruit.

Analysis from the Hawaii Agriculture Experiment Station's annual report for 1914 shows the following percentages: Waste 50.00; water, 87.00; ash, 0.27; protein, 0.63; sugar, 14.22; acidity, 0.88.

The yellow Spanish plum, a sub-species of *S. purpurea,* has a slightly smaller fruit while the foliage is smaller. The tree is hardier than the other species, being used commonly for fenceposts. The fruit is not so flavorsome as that of the red mombin, but makes a passable preserve.

Pistacia

The pistachio (*Pistacia vera*) is a small tree indigenous to Syria. It is grown throughout the Mediterranean region and in northern India. The nuts are a valuable article of commerce. This tree is not successful in southern Florida as it is adapted to regions with drier climates. It does not thrive under the hot, humid conditions such as exist in this region during the summer months.

The pistachio is mentioned in this list of plants because in Florida it is confused by many people with the physic nut (*Jatropha curcas*) many plants of which are being grown under the blissful impression that it is pistachio. *Pistacia vera* has fine pinnate leaves, the leaflets varying from one to five pairs. *Jatropha curcas* has entire leaves, three- to five-lobed and from three to six inches wide. The seeds of most forms of the latter are very purgative and should not be eaten.

Mangifera

The mango (*Mangifera indica*) is the chief species of the genus of commercial or economic value. There are some forty species in the genus, the fruits of most of them being fibrous, and strongly flavored. Investigation may disclose some characters of merit to warrant the use of some of the other species in plant-breeding, or as stocks, but at the present time *M. indica* is the only species of outstanding merit.

The mango has an ancient historic background. Mention is made of this tree being in cultivation over five thousand years ago. Mythology and folklore take it back to the earliest times, since when it has formed a part in the religious ceremonies of the people of India, being considered by them as one of their most important fruits, if not perhaps the most important. The poets also were quite active in singing its praises. One reads of Akbar, who reigned in northern India late in the 16th century, planting an orchard of one hundred thousand mango trees; such a planting attests the esteem in which the mango was held. What a wonderful opportunity Akbar must have had for improvement by selection had he cut out the natural preponderance of poor types and propagated from the better ones! The principle of improvement by selection must have been understood to some extent in those earlier days, as attested by the large list of named varieties of good quality now offered for sale in India. Propagation of selected varieties by marcottage and inarching has been practiced in India for a long time; some of the more outstanding of these varieties have been brought into the United States through the Department of Agriculture.

The mango well deserves the title of "king of fruits." From its origin in the East Indies and the Malay region, it has spread around the world and has become an economic factor throughout the western tropics, as it has been from earliest times in the East.

The first introduction of the mango to the American tropics was made in the sixteenth century, when it was brought to Brazil by Portuguese sailors. The early Portuguese, trading in India, brought the mango

from there to tropical Africa; whether it was brought to Brazil direct from India or from Africa is not clear. As the mango seed loses it viability quickly, its transportation to Brazil must have been quite a triumph. It must have been transported as a living plant and its successful transshipment by a long sea voyage at that early date was a notable feat.

From Brazil the mango spread throughout the American tropics and the West Indies, supposedly through the Spaniards and other early voyagers. There were independent introductions from the Philippines by the Spaniards. Cross-pollination and the influence of local environment have acted to produce a multiplicity of types. While these influences have produced a few specimens better than the average, the majority have been very poor and the average quality has been low. These mediocre somewhat fibrous fruits of strong flavor so common throughout the American tropics have given most visitors a very poor impression of the mango. This is unfortunate, as they have no resemblance whatever to the sweet-flavored, fiberless fruits now being cultivated. Cross-pollination and selection have given us some superior fruits, while vegetative propagation makes it possible to reproduce them true to type.

While the Indian mango types have been favorably known for centuries, two other groups are worthy of note, the carabao mango from the Philippine Islands and the Saigon from Indo-China. The Philippine mango was brought in early Spanish times from the Philippine Islands to Mexico, where it was known as the Manila mango. It is distinct from the Indian mango in shape, texture of flesh, and flavor. It is long and almost cylindrical, while the fruits of the Indian race are predominantly roundish or heart-shaped. The better strains of the Philippine mango are absolutely fiberless. The flesh has a fine, smooth texture and the flavor is more appealing to the novice. There are, of course, some very fibrous, disagreeable-tasting Philippine mangoes, but they have not been widely disseminated in Florida, and only the best are being reproduced commercially. The Saigon mango was introduced into the United States through the efforts of Dr. David Fairchild. Seeds of the better types were sent to the Department of Agriculture and planted in the Plant Introduction Garden at Miami. As with any group of plants grown from seed, there has been much variation among them. They produce from rank-tasting fibrous fruits to high-quality fiberless ones, some of them being fruits of superior quality.

The Philippine and Saigon groups appear to be more suitable than the Indian group to the climatic conditions of southern Florida. They set

fruit more freely, and are not so adversely affected by wet or foggy weather during the blooming period. It has been noted on several occasions that they have set good crops while the Indian types have failed to set, even after profuse blooming. In general behavior and in resistance to anthracnose blight of the flowers, there seems to be very little difference between the Saigon and the Philippine groups. While fruits of the Indian group are much more colorful and attractive in appearance for market purposes, the group as a whole does not have the utilitarian value of the other two groups as a steady producer of clean fruit.

The mango tree is evergreen, and although not very particular as to soils it responds readily to nourishment. On well-drained, deep soils it makes a large tree, its natural tendency being to grow to such a size that gathering the fruit becomes quite an undertaking. This tendency is not so marked in grafted trees, but more attention to stock selection by propagators would go far toward counteracting it.

Among the common fibrous fruited seedlings throughout Central America and the West Indies, two distinct types are commonly recognized, indicated as the mango and the manga. The former has a tall, upright style of growth with an open head. The fruits are long with a decided point. This type is a rank grower and should not be used as a root-stock, as it produces too much vegetative growth. This type is known in Cuba as *mango macho,* and in the British West Indies as Number 11. The manga type has a spreading style of growth with a round, dense head, and makes a more suitable root-stock. There are two sub-types of manga known in Cuba as *manga amarilla* and *manga blanca,* and in southern Florida as turpentine mango and peach mango. There is a considerable difference in the growth habits and in the fruits of these two mangas. The turpentine type is more suitable for shallow soils and is preferable for the rocky soils of Dade County; the peach manga has a deep-spreading root development and is more suitable for the deep sandy soils.

The mango tree blooms profusely, the long panicles of pink-white flowers springing from the branchlet tips. The tree often blooms two or three times, a first and second blooming being considered normal; fruits from the second blooming are generally better developed than are those from the first one. An early practice in India was to build slow fires beneath the mango trees in order to stimulate the blooming, and this is still common practice in the old world tropics. It is supposed that the smoke and dry atmosphere caused by the fires also ward off the anthracnose fungus in wet, foggy weather.

While the mango tree is very adaptable and will grow in almost any well drained soil, it responds to feeding and will generously repay any attention given it. While very little practical work has been done in the way of fertilizer tests, any well-balanced fruit-tree fertilizer should give profitable results. A good start is essential with the young tree, but when it has reached maturity the nitrogen applications should be reduced and the phosphate and potash increased. Fertilizer experiments in Cuba on mango trees grown on well-drained sandy soil show the necessity of heavy applications of potash. Applications of 1.5 pounds of nitrogen, 3.6 pounds of phosphate and 5.4 pounds of potash gave an average yield of 2000 fruits per tree, while with the same amount of nitrogen and phosphate without the potash, the average yield was 791 fruits per tree. The trees supplied with potash produced fruits that were superior in quality to those without it. According to P. V. Wagle, trees ten to twelve years old in India gave very good results with an application of 4 pounds of sulfate of ammonia and 200 pounds of barnyard manure.

While the young tree is susceptible to cold, it will withstand several degrees of frost after reaching maturity, provided the cold spells are not of long duration. Much depends on the condition of the tree. A sudden cold snap or several days of strong, cold wind, as often experienced in November, will scorch the young leaves, while mature leaves will suffer very little. Nevertheless, it is advisable to protect the trees, whenever possible, from the cold north and northwest winds.

The climatic and soil conditions of southern Florida appear to be quite suitable for the mango as shown by the multiplicity of hybrid seedlings to be found throughout the region. The weather conditions are generally favorable to fruit-setting. There are off years when rains or fog make conditions conducive to blight. These are the times when the Philippine type stands out in contrast to the more susceptible Indian race by setting good crops of fruit. Sometimes the first blooms of the Indian mangoes fail to set fruits, while the second flush of bloom, coming on three or four weeks later under more suitable weather conditions, will set fruit abundantly.

In southern Florida, while there is a high atmospheric humidity during the summer months, the almost constant breeze keeps the air fresh and the anthracnose blight is not so prevalent as might seem possible. Most of the Indian mangoes nevertheless require spraying at intervals from the time the bloom begins to burst forth until harvest time. This constant coating of the fruit with lime-sulfur or lime-copper sprays must have a tendency to retard proper coloring of

the fruit. It may be that the future trend will be toward the more fungus-resistant varieties of the Saigon and Philippine races. Trees of the three races growing side by side forcibly demonstrate this conclusion with their fruit.

In the Philippine Islands there are several types of the mango, the two important ones being the carabao, and the pico. The carabao is outstanding in quality; a tree of this type has been thoroughly at home and producing good crops of excellent fruit for a number of years in West Palm Beach. It has been neglected for several years and yet it has withstood all manner of vicissitudes, still producing a crop of high quality fruit each year. The fruit is longish, with a flat seed and a tough, smooth skin, greenish yellow when ripe. The flesh is thick, fiberless, of a smooth, fine texture and with a sweet, mildly acid flavor. It has a slight susceptibility to anthracnose, particularly the fruits inside the tree-top, where there is very little circulation of air and little sunshine; the fruits hanging free in the air and sunlight do not appear to be affected. The pico is smaller than the carabao. It bears a long, slender, more flattened fruit. The fruits of the better strains of this type are fiberless, with a fine, smooth flesh-texture and a pleasant subacid flavor, and are practically immune to anthracnose. There is great variation between individual specimens. There are some perfectly worthless specimens of the carabao and pico mangoes in southern Florida. The original Cecil, a very good specimen of the pico group, would not now recognize some of its namesakes, many of them third-generation seedlings of the original, which means three generations of cross-hybridization with other mangoes. Grafted or budded varieties only should be considered when purchasing mango trees. The Earle is perhaps the outstanding pico variety in southern Florida. The Randolph seems to be the only named variety of the carabao group at present. It is a late-maturing variety, usually ripening its fruit in late August and September.

Of the Indian race, the named varieties introduced into Florida are numerous. Over a period of years, however, the two outstanding varieties for home production are the amini and the paheri. Their fruits are bright-colored, with little fiber, and with an appealing aromatic flavor and for Indian mangoes are surprisingly free from anthracnose spottings. The amini matures its fruit early. It could reasonably be called the earliest and sweetest of the Indian mangoes. The paheri matures at about midseason. The mulgoba, the finest of all the Indian mangoes, is a very irregular bearer and is recommended for planting only in a large, assorted collection. It is not a variety for the

home-owner, with limited space for planting. Of the Saigon group there are at present no commercial named varieties, although several of these are so outstanding in quality that they should be named and released for commercial propagation. It is to be hoped that within the near future some of them will be put on sale under definite horticultural names. A few grafted trees are being offered as Saigon, but this is too general and indefinite a name to serve the purpose.

Cambodiana, introduced into Florida at an earlier date than the other Saigon mangoes, is at present the only commercially named variety. There is much difference of opinion as to its merits. This is due mainly to the number of seedling trees passing under the name of Cambodiana, even though the resemblance to the original be very slight. The original Cambodiana, although a small fruit, is one of the most promising varieties for all-round purposes; the fruit is fiberless and of a fine texture and flavor, and the tree is a good bearer.

The hybrid seedlings grown from these earlier imported Indian mangoes are innumerable, each the pride of its owner but all inferior to the parent tree from which the seed was taken. There are so many specimens of poor type, prolific with high-potency pollen for cross-hybridization, that the possibilities of getting a superior fruiting specimen from chance seed are practically nil. Under the conditions at present existing in southern Florida, only a careful breeder can hope to create a better fruit.

The outstanding hybrid of Florida origin is the Haden, a chance seedling from the Mulgoba. Brook's late, is a seedling of sundersha, although valuable as a very late maturing variety, has the sundersha susceptibility to splitting and to anthracnose spotting. Brownlow and Springfield seedlings of sundersha, both very good fruits, have the same weakness. Several hybrids produced by the late Edward Simmonds show considerable promise. For several years they have borne good crops of superior fruits. They are not yet being commercially propagated, but it is hoped that they will be available soon.

In general the mango tree has a tendency to overcrowding in the top. A system of pruning to counteract this tendency should be initiated from the early formative years. There are usually two growth periods during the year, one flush of new growth in the early spring coincident with the blooming period, and another in the fall after the fruit has matured. The flower buds are formed on the tips of the matured growth, and usually the fall growth does not mature sufficiently to develop fruit buds by spring. In poor fruiting varieties, having a strong tendency to vegetative growth, the sap movement in spring is

more inclined toward the immature tips than toward mature ones. The result is usually a strong flush of new growth instead of a flush of bloom. In experiments carried out in India, P. V. Wagle reports good results from tip-pruning the poor bearing Alfonso variety. In December the immature fall growth is cut off, leaving the mature summer tips dominant. This permits the mature tips with the latent fruit buds to receive the first push of sap in spring. In Florida a cool, dry winter is usually followed by profuse blooming in spring; this is on account of the cool weather having a maturing influence on the fall growth.

Analysis of the mango fruit from Cuba gives analysis of the average of several native varieties in percentages as: Water, 81.20; protein, 0.40; fats, 0.32; sugars, 13.54; carbohydrates, 1.48; fiber, 2.52; ash, 0.54. The coefficient of digestibility is given as: Protein, 83.00; fats, 98.00; carbohydrates, 90.00.

In "The Food Plants of the Philippines," P. J. Wester gives the analysis of several varieties: Carabao, ripe: Water, 82.80; ash, 0.45; protein, 0.22; sugar, 12.79; acidity, 8.32. Carabao, green: Water, 86.30; ash, 0.25; protein, 0.38; starch, 3.90; sugar, 1.86; acidity, 8.65.

Pico: Water, 76.40; ash, 0.40; protein, 0.75; sugar, 17.66; acidity, 0.53. Paheri: Water, 78.98; ash, 0.46; fiber, 0.40; protein, 0.83; fat, 0.16; sugar, 17.33; acidity, 0.12.

Wester and Francisco, in the *Philippine Journal of Science,* 1930, give among other figures in the analysis of *mango amini:* Moisture, 79.72; ash, 0.42; protein, 0.83; sucrose, 11.21; reducing sugars, 5.90; fats (ether ext.), 0.25; fiber, 0.61; acidity, 0.96. Calorific value per 100 gm.: 79.81.

The mango has a high nutritive value and should be included in every home planting. In many places in the tropics it is the chief food fruit of the summer months, and may be considered as the tropical equivalent to the apple in the diet. The fruit can be used for some purpose in all stages of development from the tiny, first, imperfectly set fruits to the fully matured ones.

In the Dutch East Indies the small green fruit is pickled in vinegar, resembling the olive, and is greatly appreciated as an appetite stimulant. The tender green fruits are chopped up for use in lieu of tamarind in various dishes where an acid flavor is desired. The young, tender, red leaves are used in salads.

The following suggestions for use of the fruit constitute only a small part of the possible uses to which it may be put. In the Dutch East Indies even the kernel of the seeds are used as food by making a flour from them, which is mixed with sugar and coconut milk and eaten

as a porridge. Housekeepers familiar with the culinary uses of the apple and peach will soon learn to substitute the mango. Only green fruit may be used for making jelly, and quite a difference can be noticed in the jelling qualities and flavor of the different varieties. The very small green fruits are used chiefly for pickles and chutneys, while the fully ripe fruit should only be eaten uncooked. For baking purposes, such as pies or fruit puddings, cobblers, etc., the fully grown, slightly colored fruits are better for pies, giving a product similar to apple pie, while the more mature softer fruits are better for puddings and sauces.

Perhaps the commonest use for the first half-developed windfall fruits is the old favorite mango sauce, twin to the apple sauce of the North. Fruits not more than an inch or an inch and a half in length may be peeled and boiled whole with a small amount of water. Passing the pulp through a colander will remove the seeds and any fiber that may be present, after which an equal amount of sugar is added and boiled long enough to incorporate thoroughly the sugar and pulp. By cooking in a double boiler, the pulp may be made stiff enough to slice on cooling.

ANNONACEAE

The *Annonaceae* is an interesting family of over forty genera, mostly from tropical and subtropical regions of both hemispheres. The genus *Annona* is the most important one. Another genus with possibilities for development is the *Rollinia*. The biriba (*Rollinia deliciosa*) is claimed to be an exceptionally good fruit of northern Brazil. It has not been very satisfactory in Florida, and the fruits have been of a poor quality. It may be that we have been unfortunate in acquiring a poor strain of seedlings and that further trials may be worth while. At the best, however, it is rather tender for southern Florida and suffers in the frequent cold snaps. The fruit somewhat resembles the cherimoya.

To this family group also belongs the genus *Asimina,* of which *A. triloba* is the papaw of the southeastern states. Among the ornamental plants of this family grown in southern Florida, the ilangilang, (*Canangium odoratum*) famous for its perfume, and *Artobotrys uncinatus,* the false or climbing ilangilang, have been quite successful.

Many of the plants of this family have reputed medicinal value. Infusions of the bark, leaves, or roots of many of them are in daily use in various parts of the world for alleviating fevers and for treating disorders of the digestive tract.

Annona

The genus *Annona* comprises more than fifty species of trees and shrubs which, with few exceptions, are indigenous to tropical America

or the West Indies. The various species have a promising future in the hands of the plant-breeder. The characteristics of the different species seem to be so distinct that they almost constitute pure-line materials for blending by the plant-breeder.

Several species of *Annona* have already proved suitable to conditions in southern Florida; others in test plantings may prove valuable either as hardy root-stocks or as breeding material in creating new types. There is always room for improvement, and the available types could be greatly improved in the size, flavor and productiveness of the fruits, and in the hardiness of the plants.

The annonas were among the first fruit trees introduced in southern Florida by the early settlers. They were planted under many different conditions of soil and exposure, and in general they proved to be quite adaptable, although each species showed some preference for certain conditions. In general they are highly tolerant of lime soils. The sugar apple (*Annona squamosa*) is quite at home in potholes in the coral lime rock of the Keys and throughout the rocky soils of Dade County. The soursop, (*A. muricata*) is not very adaptable to lime soils, preferring deep, well-drained humus soils. The custard apple or bullock's heart (*A. reticulata*) has no marked preference as to soils, provided they are not too wet. With the exception of the pond apple (*A. glabra*) the annonas do not thrive in wet places.

In general the annonas respond well to nourishment. An annual application of cow manure, combined with a good mulch to maintain an even soil moisture, especially on the drier sandy soils, will give good results.

Throughout the tropics, there appears to be a great deal of superstition about some of the annonas. The pond apple is considered to be poisonous in some parts of Cuba. In Ceylon the bullock's heart is supposed to cause leprosy, and in Central America the soncoya (*A. purpurea*) is blamed for causing chills and fevers. The leaves of the sugar apple are used as a poultice for infected wounds, while the root is highly purgative.

At present there are no superior strains or varieties of the different species being propagated commercially in Florida. The atemoya is a cross between the cherimoya and the sugar apple. With so much natural variation in seedlings, there must be individual plants better than the average. Investigations along this line are very important, and the problem of suitable root-stocks also demands attention. With the idea of testing their suitability for such purposes, the following species are among the more important being planted in experimental gardens.

Annona purpurea, from Mexico to Panama, is a strong, open-growing tree with large leaves. It is suitable for dry soils but is inclined to be topheavy, like *A. reticulata.* It has a large, fleshy fruit with bright-orange flesh.

Annona spraguei is a small-fruited species from the Panama region. It may be of value as breeding stock.

Annona spinescens, from Brazil, is a small tree or spiny shrub, the foliage resembling that of the governor's plum. The fruit is small, round, and dark orange in color. The flesh is salmon pink and practically flavorless. Its strong points are its hardiness of growth and the bright color of the fruit. It may have merit for breeding purposes.

Annona bullata, from Cuba, is a small, upright tree of open growth with tough leathery leaves. The fruits are yellow when ripe; the flesh is dirty white and is dry and tasteless, the fruit being small and seedy. The tree appears to be quite hardy and is suitable for dry soils, which makes it worth trying out as a root-stock for other annonas.

Annona diversifolia, from Central America, grows well on the deep, sandy soils of southern Florida but has not fruited so far. It is a small tree with large fruits of good quality. The tree is similar to the cherimoya in preferring the higher levels, so that the more humid sea-level climatic conditions of southern Florida may not be suitable for its successful development.

Annona macrocarpa, from Brazil, is a small tree of slim growth, with foliage somewhat similar to that of the sugar apple, and fruit very similar to it in size and appearance; the flesh, however, is disappointingly flat in flavor. This tree may have possibilities as a root-stock.

Annona testudinea, from Honduras, and *A. scleroderma,* from Guatemala, are hard-shelled species of possible value in breeding for shipping qualities.

Annona senegalensis is a small, open-growing tree from Africa, with a small, edible fruit. Its chief interest lies in its suitability as a root-stock for other annonas, for which purpose it is now proving to be very successful, being more compatible with other annona species than *A. glabra.*

Annona montana, from the West Indies, resembles the soursop tree in growth. The leaf is similar but larger and the fruit smaller and of little merit. The tree is suitable for drier soils and may have merit as a root-stock.

Annona glabra, the pond apple, is native to the West Indies and Central America. It grows wild throughout the Everglades and in low wet places along the coastal strip of southern Florida. The fruit is round,

with a smooth skin turning yellow when ripe. The flesh is fibrous and has a disagreeable flavor; although not a very desirable fruit to eat, it is not poisonous, as so often believed. The tree grows well on deep, sandy soils and makes a better root-stock than the custard apple or the sugar apple for these soils.

Annona cherimolia

The cherimoya (*Annona cherimolia*) is perhaps the earliest recorded fruit of the New World. Terra cotta vases of pre-historic times were modeled from the cherimoya in Peru.

It is considered to be the hardiest species of the annonas. A small tree growing at higher altitudes, it is not successful near sea level, but reaches its best development in the higher mountain levels of Mexico and Central America. It has become well-established in upland areas throughout the warmer regions of the world, in some places being grown in quantity for the market.

The tree grows fairly well in southern Florida but fruits poorly. The high humidity of the summer months does not agree with it. The fruits are variable in size, shape, and quality. The flesh is white and mildly acid, and in general the flavor is very good.

Although not to be recommended for home planting, the cherimoya should be grown in test plantings. On account of its hardiness and superior quality of its fruit, it has great value for breeding.

In Cuba, the name cherimoya is applied to the custard apple or bullock's heart, *Annona reticulata.*

Annona muricata

The soursop (*Annona muricata*) is an upright-growing tree, with dark, leathery, laurel-like leaves, having a distinctive pungent odor when crushed. It is evergreen in the tropics except on dry soils, but is deciduous in Florida, sometimes remaining bare of leaves for several weeks during the winter months. It is now general throughout the tropics, although a native of tropical America. In Cuba its fruit is a favorite, and the tree may be found in almost every yard planting.

The soursop is the most tropical of all the annonas. It is very susceptible to cold and should only be planted where it may be protected from the cold north and northwest winds. Possibly the most flourishing planting of soursops in Florida is to be found in the colored section of the town of Boynton. There are many bearing trees scattered throughout the section among the houses. The soil is a deep, well-

drained, poor, white sand, but the trees are well mulched and benefit from plenty of fish scraps dug in around the roots. During a cold spell the wood fires in the houses are kept burning all night for comfort; the result is a warm smudge all over this area. The smoke screen is unintentional so far as protection for the trees is concerned. Nevertheless, the results are good for the trees suffer very little and fruit well.

The soursop develops best in a deep, rich, well-drained soil and is not tolerant of lime soils as are some of the other species of *Annona*. It can be successfully grown on the sandy soils by digging in compost or dairy manure and top dressing every year with dairy manure or compost and chemical fertilizer. While the tree should get most of its required nitrogen from organic fertilizers, an application of phosphates and potash will prove beneficial for flower and fruit development. It has a shallow fibrous root system close to the surface, so that a good mulching is necessary, as well as frequent irrigations during summer dry spells.

The growth is fairly uniform, with a head of well-balanced foliage, and is not subject to crowding in the top. The tree does not appear to require pruning for flower and fruit development. So far, there are no horticultural varieties of the soursop. Attention to the vegetative propagation of better strains and to suitable root-stocks has now become a necessity for the advancement of this worthwhile fruit.

The fruit is large, tapering and heart-shaped, green in color, with numerous fleshy, spine-like protuberances, and weighs from three to six pounds, some well-developed fruits weighing up to seven or eight pounds. The aromatic flesh is white, of a cottony texture, the juice with a very agreeable and distinctive sub-acid flavor. The fruit is sometimes used green in making preserves, but is generally used ripe in custards and ices. It is a favorite in Cuba, and the "champola" made with strained pulp and milk is one of the famous fruit drinks of Havana. In the Dutch East Indies, the juice mixed with wine or brandy is a favorite drink.

Analysis of the soursop, or guanabana, from Cuba shows the following percentages: Edible part, 72.00; water, 81.00; protein, 1.70; fats, 0.80; sugars, 12.00; starches, 1.10; cellulose, 1.80; acids, 0.90; ash, 0.70. Coefficient of digestibility: Protein, 86.00; fats, 93.00; carbohydrates, 94.00.

Annona reticulata

The custard apple or bullock's heart (*Annona reticulata*) is indigenous to tropical America and is now widely distributed throughout the tropics and sub-tropics. In general it is of indifferent quality. It bor-

ders on being a good fruit and has possibilities for breeding. In recent years some interesting seedlings have been introduced into Florida; some of these should prove of value in hybridization.

The tree is quite hardy in southern Florida, shedding its leaves at the beginning of cool weather and remaining dormant the greater part of the winter season. It is a small tree, of sprawly growth, and has a straggly, uneven root system, as a result of which it readily inclines through topheaviness or from winds. It is not so successful as the sugar apple on rocky soils or deep, dry, sandy soils, but prefers the deeper moist soils where water does not stagnate around the roots. Pruning is advisable in order to counteract the sprawly growth and preserve a balance of shape. There is also a tendency to overcrowding in the top as the tree grows older. The soft water sprouts should be pruned out.

The fruit weighs from one to two pounds and is smooth, roundish or heart-shaped, from four to five inches in diameter, and brownish-red when ripe, often with a bright-red cheek where exposed to the sun. The flesh is creamy white, and inclined to be dry, sweetish and rather insipid in flavor. The fruits of some of the introduced seedlings are of better flavor and trees producing these should be propagated by budding or grafting.

The fruit may be used in custards or ices. As with the sugar apple and the soursop, it makes a good milk drink with the addition of a little sugar and a pinch of salt.

Analysis from Cuba, in percentages, shows: Water, 73.00; protein, 1.80; fats, 0.50; sugars, 18.70; starches, 2.00; fiber, 2.90; ash, 1.10. Coefficient of Digestibility: Protein, 84.00; fats, 93.00; carbohydrates, 92.00.

Annona squamosa

The sugar apple (*Annona squamosa*) is indigenous to Central America and the West Indies. It is quite hardy in southern Florida and deserves to be more widely planted. It has been grown commercially in the Florida Keys for several years. Interplanted with Key lime, it shows a high tolerance of lime soils and a resistance to long periods of drought. It is perfectly hardy in Palm Beach County, but is not so well adapted to the deep, well-drained, sandy soils of that area as it is to the rocky soils of Dade County and the Keys. It is not a deep-rooting tree, most of the feed roots being close to the surface. In the deep, sandy soils, however, it responds well to applications of organic manure and mulching. It is adaptable to almost any well-drained soil and responds to

feeding, the size and quality of the fruit depending largely on the vigor of the tree.

The sugar apple at the present time is the most satisfactory of the annonas for growing in southern Florida, being quite productive. No superior strains or horticultural varieties of this species have so far been propagated commercially in this state. Some excellent seedlings are to be found among some of the earlier plantings, and more attention should be given to its cultural requirements than it has so far received.

On soils inclined to be dry the sugar apple should be well irrigated during dry spells at the time of fruit development. While the tree will withstand drought very well, it does so to the detriment of the developing fruit by going dormant and sometimes shedding its leaves. The pericarp then becomes toughened and cannot readily expand on receiving a renewed push of sap, the result being split and ruined fruit. The tree sheds its leaves on the advent of cold weather and may stay dormant until spring, depending on the temperature and rainfall during that time.

There is much variation in the quality of the fruits, and trees yielding the better ones should be grafted or budded. Seedlings of the sugar apple make good root-stocks, the great drawback to their use being the difficulty in distinguishing between the adventitious shoots of the root-stock and those of the graft. All sprouts growing out from low down on the stem should be cut off when there is doubt as to their origin.

The fruits should be picked just before maturity, as they split open when ripened on the tree. They vary from two and a half to four inches in diameter. The flesh is creamy white, sweet, and of a pleasant flavor. It does not lend itself to cooking and should be used as a table or dessert fruit. As with the soursop, the strained pulp makes an excellent drink when mixed with milk. In employing the pulp for ice cream it should be added to the cooled custard just before putting it into the freezer.

Among the natives of the tropics the sugar apple tree is of reputed medicinal value. Tea made from the roots is highly purgative, while that made from the leaves is mildly laxative and is also considered to have a general tonic effect on the digestive tract. Poultices of the leaves are used in dressing infected wounds. The tree requires very little pruning beyond the cutting out of occasional water sprouts from the top and the cutting back of any oversized side shoots.

Analysis from Cuba shows the average composition of the fruit in percentages to be: Edible portion, 72.00; water, 72.00; protein, 1.95;

fat, 0.40; sugar, 21.50; fiber, 2.20; ash, 0.95. Coefficient of digestibility: Protein, 85.00; fats, 93.00; carbohydrates, 96.00.

The food value of this species is principally due to the richness in sugars, glucose and sucrose being found in almost equal proportions.

Annona squamosa × cherimolia

The atemoya, one of the hybrids resulting from the cross-pollinization of the sugar apple with the cherimoya, is an excellent fruit, well-adapted to the climatic conditions of southern Florida. The tree has an open, spreading growth, the fruit having more of the characteristics of the cherimoya than of those of the sugar apple. Over a period of several years it has proved to be quite hardy and a good bearer; the fruit is of excellent quality. Being a hybrid, the tree must be propagated by budding or grafting. It has grown quite satisfactorily when grafted on the root-stocks of the sugar apple and the custard apple, but does not thrive so well when grafted on that of the pond apple. Until further information is available, the sugar apple stock is the most satisfactory one for rocky soils, as well as for dry, sandy soils. The tree requires some pruning in order to control the spreading growth and maintain an open top. The fruit appears to be hardier than that of the sugar apple and with better shipping qualities, having a harder shell and being less apt to split when ripe.

Analysis from the Philippine Islands, according to Francisco and Wester, show the following percentages: Moisture, 71.48; ash, 0.75; protein, 1.07; sucrose, 7.18; reducing sugars, 12.82; fats, 0.45; fiber, 0.05; starches, 5.40.

APOCYNACEAE

The Apocynaceae family contains over one hundred genera, found mostly in the tropics and subtropics. These include many plants with poisonous or bitter, always milky sap, *Carissa* being the only genus with edible fruits of economic value. Many plants of this family yield fruits with poisonous seeds, some of which are used in the practice of medicine. Some of the better-known genera of the Apocynaceae grown in southern Florida as ornamental plants are *Allamanda, Tabernaemontana, Nerium,* and *Beaumontia.*

Carissa

There are some thirty species of the genus *Carissa;* very few of them have fruits of economic value, most of them being straggly growing, spiny shrubs of possible value as ornamentals or as protective hedge plants.

Carissa is one of the most successfully established fruits in southern Florida, being adaptable to all except the very wettest of soils. It has in general been planted more for its ornamental value than for its fruits. There is much variation in the type and in quality of *Carissa* fruits, thus creating possibilities for improvement through selection of existing good types and propagation by vegetative means.

Several species of *Carissa* not generally planted, are to be found in test plantings, and about some old homesteads. These may have value as root-stocks or for hybridization. As *Carissa* grows so well on its own roots and superior strains or varieties can be readily propagated by layering or by marcottage, there seems to be very little point in seeking compatible root-stocks. However, Firminger, an early English horticulturist in India is authority for the statement that *Carissa grandiflora* is more productive and less liable to strong vegetative growth when grafted on *C. carandas*.

Carissa acuminata is a dense, spiny, upright-growing bush with small, sharp-pointed leaves. The fruit is very small and of no economic value; the bush makes a good ornamental plant.

Carissa edulis is a straggly bush with long, slender shoots and fine leaves. The fruit is small and black when ripe and contains only one seed. It has possibilities as an ornamental plant.

Carissa spinarum is a very spiny, sprawly-growing bush with small leaves. It appears to be of very little economic value.

Carissa arduina (*C. bispinosa*) was introduced into Florida several years ago. It is not very common and is generally confused with *C. grandiflora,* of which species it is often considered a poor strain. The fruits are smaller than those of *C. grandiflora* and of a poor quality. The plant is not so showy and ornamental as the larger-flowering *C. grandiflora.*

Carissa grandiflora, the Natal plum or amatungula, is a native of South Africa. It is a very ornamental plant with its dark, glossy leaves and white, star-like flowers with a strong jasmine scent. The bright-red fruits, varying from one and a half to two inches long, are very attractive against the dark-green foliage. In southern Florida it is chiefly used as an ornamental plant.

There is a great variation in size and quality of its fruits. Some types are almost round, while others are long and pointed at both ends. In quality they range from soft, watery, many-seeded fruits to firm, almost solid ones. As with the quality of the fruits, there is also much variation in quantity on various plants, some being very prolific while others flower freely but fail to set more than a few fruits. So far only one

superior type has been selected in Florida. This is commonly known as the Gifford type. It has a large, thick, fleshy fruit of good quality, and the plant is very prolific. Better types should be propagated vegetatively, as this is the best means of reproducing them true to type. A very small percentage of seedlings come true to type.

The Natal plum makes an excellent hedge plant, and when kept trimmed it is quite fruitful. The fruit is borne on the tips of the young growth, so that trimming, if not overdone, is conducive to the development of fruiting tips. The plant may also be trained as a vine, but the straggly growth is generally not very productive. The good fruiting types are usually of a shrubby style of growth. As vine, hedge, or bush, it should always be planted in bright, sunny locations. It is not at all fruitful in the shade.

The young plants are tender, but on acquiring woody growth they become quite hardy. The plant is not particular as to soils but fruits best on lighter, well-drained soils. It is quite resistant to drought, but during the fruiting season it should not be allowed to suffer for lack of water to the detriment of fruit development.

The partly ripe fruits make an excellent jelly, very similar to cranberry jelly in flavor and of a fine texture and color. This is not a good jam fruit, but the fully ripe ones are very good in pies, or they may be used sliced in salads.

As a fruiting bush the plant does not require much pruning, beyond a frequent cutting back in order to counterbalance its exuberant growth. If allowed to grow unmolested, it becomes too spreading to permit easy picking of the fruit on the upper part of the bush.

The annual report of the Hawaii Agricultural Experiment Station for 1914 gives the following analysis in percentages as follows: Water, 78.45; ash, 0.43; fiber, 0.91; protein, 0.56; fats, 1.03; sugar, 12.00; acid, 1.19. Calories per kilo of food: 594.

Carissa brownii

The hardy species (*Carissa brownii*) comes from Australia and is much more cold-resistant than the other species. It has withstood several degrees of frost practically untouched, while other species have been killed back to the hard wood.

The plant is of a stocky, compact growth, with small, roundish, close-set leaves and short, sturdy spines. The fruit is about an inch in diameter and of brownish or rust color when ripe. The flesh is white and almost solid; the flavor is agreeable although quite acid. The fruit

makes a firm jelly of a very pleasant flavor. From its jelling qualities it appears to have a higher pectin content than any of the other species.

There are very few plants of this species in cultivation in southern Florida. It is to be found in some of the early homestead plantings but has been neglected in later ones. It is quite prolific and deserves to be more widely planted.

The plant is of slow growth, and requires a richer soil than is necessary for the strong-growing Natal plum. While resistant to drought, it requires a good moist soil for best results. It responds well to feeding, and the size and quality of the fruit depend on the well-being of the plant.

As a stocky, compact grower, it does not require pruning for fruiting purposes. It does have a tendency to become too dense, so that a thinning-out of the interior growth may be necessary at times.

Carissa carandas var. **amara**

The caranda (*Carissa carandas* var. *amara*) is a native of India. In southern Florida it makes a strong, straggly-growing shrub suitable for a protective hedge planting. Its clusters of small, jasmine-like flowers are very fragrant and attractive against the dark-green foliage.

The plant may be grown as a vine, and if kept trimmed to encourage twig growth in place of strong, straggly shoots, it is very attractive with its white flowers and black fruits. On account of its tendency to rank growth, it should be planted only in dry, sunny locations. It grows well, and is very fruitful on deep, well-drained sandy soil.

The fruits are black when ripe, oval, and about three quarters of an inch in length. The flesh is pink and quite sour. The fruit makes an excellent jelly for serving with meat or fish. The fruits are very gummy, and on first starting to cook appear to be a hopeless mess; the juice soon clarifies, however, and makes a clear, claret-colored jelly. In India the green fruits are pickled; a very good dry wine has been made from the ripe fruits in Florida.

Wester, in "The Food Plants of the Philippines," gives the following analysis by percentages: Water, 83.17; ash, 0.78; fiber, 1.81; protein, 0.66; carbohydrates, 0.51; sugar, 7.35; acidity, 2.09. Calories per kilo of food: 753.

Carissa carandas var. **dulcis**

The perunkila (*Carissa carandas* var. *dulcis*) the sweet form of the caranda, is native to India. In general growth and appearance it is similar to the caranda; the foliage is not so dark-green in color, but the flowers are more fragrant. In growth the plant is similar to the caranda,

being very straggly and requiring frequent pruning in order to restrain the long, sprawly shoots.

The fruit is roundish, about an inch in diameter, and dark brown or rusty black when ripe. The flesh is cream-colored, and of a pleasant, sub-acid flavor. The fruit is quite high in pectin content and makes a very good jelly; not being so acid as the caranda, it makes an acceptable table jelly, clear pink in color.

Analysis from the Philippine Islands show the fruit to contain by percentages: Water, 83.24; ash, 0.66; fiber, 0.62; protein, 0.39; fats, 2.57; carbohydrates, 0.94; sugar, 11.58. Calories per kilo of food: 745.

ARACEAE

The Araceae is a large family consisting chiefly of large-leaved, tender plants, most of them grown as ornamentals. In the tropics some species with large starchy roots, such as the taro (*Colocasia*) yautia (*Xanthosoma*) *Cyrtosperma* and *Alocasia* are extensively grown as food plants. *Monstera* is the only genus of interest to us in this work on account of its edible fruit.

Some of the more commonly known genera of this family are *Alocasia* (elephant's ear), *Colocasia* (taro), *Caladium, Philodendron, Richardia* (calla lily), *Anthurium,* and *Pothos.* The family consists of over one hundred genera, found mostly in moist tropical forests and swamps. Most species have acrid juices due to the presence of myriads of microscopic needle-like stinging crystals. On account of their vegetative and floral characters many are employed as ornamental plants and are favorites in conservatories.

Monstera

The cerinam (*Monstera deliciosa*), a native of Mexico, is the only species of this genus grown for its edible fruits.

The cerinam is a climbing aroid with very large scalloped and perforated leaves, sometimes two feet long or more. The fruit is long and cylindric, from seven to ten inches long and about two and a half inches thick; the markings on the skin resemble a pine cone. The fruit turns greenish-yellow on ripening, one of its peculiarities being that it does not mature evenly but ripens gradually, a part each day, over a period of three or four days. As the fruit ripens, the six-sided sections turn yellow and split apart, at the same time separating from the flesh of the fruit. In order to avoid bruising the soft pulp of the fruit, it should be set on end in a vase or jar. The shell from the ripened part may then be easily picked off and the latter cut off without bruising. The flesh is grayish-white and juicy, sub-acid, and of an excellent flavor and

quality. It has an attractive pineapple aroma, and has been likened in flavor to a mixture of pineapple and banana. It may be eaten as a dessert fruit or the pulp may be used in ices or drinks.

The plant is quite hardy in southern Florida and is not at all particular as to soil. It grows as a self-supporting vine on tree-trunks or stone walls, but is more fruitful when allowed to straggle over the ground. On account of its highly ornamental leaves, it is usually grown as a vine and makes a very showy plant. It responds to feeding and appreciates rich humus soil as much as any other fruiting plant.

Analysis of this fruit from the annual report of the Hawaii Agricultural Experiment Station for 1914 shows the following percentages: Water, 77.88; ash, 0.85; fiber, 0.57; protein, 1.81; fat, 0.20; sugar, 16.19; acidity, 0.35. Calories per kilo of food: 737.

CACTACEAE

This is essentially an American plant family although now, throughout the warmer parts of the world, there are places where various species are grown as economic plants for their fruit. The most important genus from an economic point of view is *Opuntia,* or the prickly pear. Fruits of several species of *Cereus* are used in Mexico, and to a lesser extent the fruits of *Hylocereus* and *Lemaireocereus.*

Throughout the West Indies, a species of *Pereskia* is grown. *Pereskia aculeata,* the Barbados gooseberry, is a straggly climber with small, winged, yellow fruits about three-quarters of an inch in diameter. They are very agreeable eaten out of hand or when made into preserves. The vine is very attractive when in flower and may be used equally well as an ornamental plant.

The fruits of *Opuntia* are claimed to have a beneficial action on the digestive system. They have an agreeable flavor and are very refreshing. In times of poor crops, they form the principal food of many of the poorer people in parts of Mexico. The young shoots also are used as a vegetable.

Very few of the large-fruited species of *Opuntia* can be successfully grown in southern Florida, the atmospheric humidity being too high. They can, however, be grown with special care, but their value here is chiefly as ornamental plants.

CARICACEAE

The Caricaceae is a small family group indigenous to tropical and subtropical America. The genus *Carica,* contains plants of economic value cultivated for their fruits.

The papaya (*Carica papaya*) is classed as a tree. It has a soft, succulent growth, the older stems becoming tough and fibrous. It is usually a single-stemmed plant but branches freely on losing its top through injury. Some of the small-fruited, strong-growing plants branch freely. The lobed leaves are large and tender, eighteen to twenty-four inches across, with long stalks. They reach maturity quickly and fall, so that the green leaves are clustered on the younger growing parts. The young fruits set at the top of the stem among the leaves. By the time the fruit is fully grown the leaves have fallen, leaving the ripening fruit on the bare stem.

The papaya is often grown purely as an ornamental plant in conservatories and patios, the large leaves giving a striking effect in plant groupings. In good soils with sufficient moisture the plant may reach a height of fifteen to twenty feet.

The melon-like fruits vary considerably in size, shape, and quality. The fleshy pericarp is from one to two inches thick, enclosing a large cavity with a varying quantity of round seeds adhering to the sides. The ripe fruit is used as a dessert, being eaten in the same way as is the melon. The fine-flavored fruits do not require seasoning; many of them, however, need a touch of salt or lemon juice. The fruit has high digestive properties due to the presence of a digestive ferment papain and is considered by dietitians to be of special merit for invalids. The pulp of the ripe fruit also makes good custards and ices. The green fruit has several uses. In the East Indies, where it is grown in large quantities, it is scored to cause bleeding of the milky sap, this being collected in glass or porcelain cups. The sap is then spread out, usually on glass, and dried to a coarse, flaky powder, in which form it is shipped to chemical manufacturers for processing. This product is known as papain; it has high digestive properties, used as a substitute for pepsin in digestive medicines. In the West Indies and Central America, pieces of the green fruit are often cooked in stews in order to tenderize meat. The leaves, crushed or slightly chopped to facilitate bleeding from the thick main veins, are wrapped around meat or packed between slices of meat for fifteen or twenty minutes for the same effect. The meat is then washed so as to prevent too great a digestive action of the sap. In tropical Asia the tender leaves and shoots are cooked as a green vegetable. They are first parboiled to extract the bitterness, then boiled in fresh water, often with the addition of a few guava leaves for flavoring. Fully grown green fruits are high in pectin but low in acid. At this stage of development the fruit is flavorless when cooked, thus making it an ideal medium for blending with high-acid fruits of low pectin content

in jelly making. The fruit must be ground fine and cooked for quite a long time in order to release the pectin.

The plant is fairly hardy in southern Florida. Like the banana, it requires a sheltered location and plenty of good soil. It is necessary to prepare special holes, and to supply plenty of water so as to maintain a strong, succulent growth. Should the plant be stunted for lack of nourishment or water, the fruits will be poorly developed and of a disagreeable flavor.

The papaya does not come true to type from seed. It seems to have a strong inherent tendency toward variation. There has been so much cross-pollinization among the types that only a small percentage of a batch of seedlings bear fruit resembling those of the parent plant. Grafting has been resorted to, but the grafted plants degenerate rapidly on reaching maturity. It is possible to propagate the plant from tender tip cuttings by using a closed frame and bottom heat.

Some types of the papaya carry so many fruits that the latter injure each other by crowding; this also creates hiding places for injurious insects. Where the fruits do not hang free and separate without crowding, they should be thinned out while still quite young. This will also have a tendency to allow the remaining fruits more sap for better development.

The following analysis, in percentages, is from the Hawaii Agricultural Experiment Station report for 1914: Ripe fruit, edible portion: 83.00; total solids, 10.59; ash, 0.56; acids, 0.05; protein, 0.38; sugars, 8.02; carbohydrates, 8.02; fat, 0.18; fiber, 0.69.

EBENACEAE

In the ebony family, the most important genus is *Diospyros,* which contains about three hundred species, principally trees and shrubs of timber or ornamental value. The *Diospyros* species with edible fruits are of very little immediate promise for southern Florida. Several species are being grown in test plantings, but their future value seems to depend more on the work of the plant-breeder than on the skill of the practical horticulturist.

Diospyros kaki, native of China, the oriental persimmon, is really a northern Florida fruit requiring a touch of frost to ripen the fruit properly. Several varieties are growing and fruiting in the southern part of the state, but they are not at their best there and cannot be considered successful. This oriental persimmon is extensively grown in China and in Japan, where it is considered one of their most important fruits.

Diospyros ebenaster, the black sapote, is a native of Mexico. It

has a flattish, round fruit about four inches in diameter, a green skin, and a blackish, soft, sweet pulp. This species has fruited in Cuba and a tree has been fruiting for several years in Palm Beach County.

Diospyros discolor, the mabolo, from the Philippine Islands, has a large, usually globose fruit covered with reddish velvety hairs. The flesh is dark cream colored, with a rather unpleasant odor and rather dry for eating out of hand. None of the few trees in southern Florida have yet produced fruit.

ELAEAGNACEAE

The representatives of the Elaeagnaceae are woody shrubs, vines, or small trees grown chiefly for their ornamental foliage and berries. To this family belongs the buffalo berry (*Shepherdia argentea*) of the upper plains region of North America, the fruit of which is edible and which is commonly used in making jellies and preserves.

Elaeagnus is the only genus of this family having tropical species with fruits of economic value. It consists of many species, chiefly of ornamental value, some of which have edible fruits.

Elaeagnus philippensis, the lingaro, from the Philippines, is worthy of cultivation both as an ornamental and as an economic plant. The fruits make an excellent jelly of a clear, bright color. The flowers are small but numerous, with a pleasant jasmine-like perfume. The fruits are about three-quarters of an inch long, dull pink with silvery spots; the pulp is sub-acid and of good flavor.

In southern Florida the plant has proved to be quite hardy and has fruited freely. It is successful on dry rocky soils but responds well to good feeding. The fruits are apt to be bitter if water be lacking during the development period.

The plant grows as a spreading shrub. It throws out long shoots, and with proper pruning can readily be trained on a trellis or wall. For better fruiting, it is advisable to thin out the crowding growth from the center of the bush.

Elaeagnus pungens, the oleaster, three varieties of which are listed, is a more hardy species than *E. philippensis,* but does not appear to be so valuable as a fruiting shrub.

ELAEOCARPACEAE

Muntingia calabura, the capulin, is a native of tropical America and the West Indies. There are two types, one with red, the other with pale-yellow fruits. It is a small quick-growing tree, with soft wood and soft, linden-like leaves, small white flowers and soft sweet fruits.

The tree has proved to be quite suitable to the light sandy soils of southern Florida, and is fairly hardy on attaining its growth. It grows rapidly, and fruits within two years from seed. Then full-grown it forms a spready-topped tree about fifteen feet in height. The branching is open, with many side shoots and fruiting twigs. This is an interesting fruit to eat out of hand. The berry, about half an inch in diameter, contains a very sweet, juicy pulp and numerous minute seeds. Being a quick, soft-growing tree, the capulin readily responds to feeding. The almost horizontal limbs should be cut back every year or so in order to prevent breaking by their own weight.

EUPHORBIACEAE

The *Euphorbiaceae* is a family of over two hundred genera found chiefly in the warmer regions of the world. Some are purely ornamental, like *Codiaeum* and *Acalypha;* some are medicinal, as *Ricinus* and *Jatropha.* To this family group also belongs *Hevea,* the commercial rubber tree. Fruiting trees of interest for southern Florida are representations of *Antidesma,* and *Phyllanthus.*

Antidesma

There are over seventy species known of *Antidesma.* The only ones of economic interest for southern Florida at present are *Antidesma bunias,* the Chinese laurel or bigney from India and Malaya, and *A. platyphyllum,* from Hawaii.

The bigney is a spready-growing, small tree. The leaves are a dark glossy green somewhat like the laurel. The flowers are small and borne in spikes. The racemes of small red fruits, turning black when fully ripe, resemble currants. The partly ripe fruit makes a very good jelly. It is not very high in pectin content, and should be supplemented with green papaya or artificial pectin. The tree is grown quite successfully in southern Florida and bears a profusion of fruits. In the Dutch East Indies the leaves are used in cooking; an extract is also made from them to relieve nausea from overeating.

Wester gives the following analysis, in percentages, from the Philippines: Water, 94.80; ash, 0.78; protein, 0.75; sugar, 0.00; acid (sulfuric), 2.13; acid (citric), 2.78; waste, 20.00.

Antidesma platyphyllum is of more upright growth and makes a larger tree than does *A. bunias;* the fruits are smaller but are produced in larger and more compact clusters. The mature fruit makes good wine or syrup. The pink or light-red fruit makes a good jelly but like

A. bunias it is weak in pectin. There is no record of this species having been fruited in Florida. It appears to be quite as hardy as *A. bunias*.

Phyllanthus

There are numerous species of *Phyllanthus*, chiefly trees and shrubs, some cultivated as ornamentals, the two fruiting species of value being *Phyllanthus emblica* and *P. acidus* (*P. distichus*, *Cicca acida*, *C. disticha*).

Phyllanthus acidus, the Otaheite gooseberry, from India and Malaya, is a small tree with spready-growth habit, bearing its fruits in racemes on the mature shoots and young branches. The fruits are pale green, roundish, and slightly ribbed, and are about an inch in diameter. The seed is quite large for the size of the fruit. This species is grown in home yards throughout the West Indies for its acid fruits, which are used in making pickles and preserves.

Phyllanthus emblica, the myrobalan from tropical Asia, is an upright-growing, many-branched tree with fine foliage. The fruits are borne singly on the mature twigs; they are light green in color, round, smooth and not ribbed like those of *P. acidus*. The ripe fruits may be eaten raw but are usually used for preserves. The fruit is very acid and makes a stiff jelly; for the best results it requires dilution with a low-acid fruit.

These two species of *Phyllanthus* are adaptable to the soil and climatic conditions of southern Florida. While *Phyllanthus emblica* is the finer and more attractive tree, it is not so fruitful as is *P. acidus*.

FLACOURTIACEAE

In the Flacourtiaceae there are only two genera of economic interest to us at the present moment, *Dovyalis* and *Flacourtia*. Representatives of other genera are grown for the ornamental value of their flowers or fruits. There are over seventy genera in the tropics of both hemispheres.

One interesting member of this family is *Pangium edule*, of the Malay Archipelago, a tall tree bearing a very large russet-brown fruit containing large nut-like seeds surrounded by a sweet, aromatic, edible pulp. The seeds are poisonous in the fresh state and must be processed by washing and fermenting (or cooking and fermenting) before being fit to eat. Most parts of the plant are permeated with hydrocyanic acid and the leaves are used to wrap maggot-infested meat. The maggots die and fall off, and the meat is then washed and prepared for food.

Dovyalis

Dovyalis (*Aberia*) is a group of small trees or shrubs, eleven species being recorded from Africa and Ceylon. At the present moment there

are only two species of this genus of value for planting in southern Florida, *Dovyalis caffra* and *D. hebecarpa*. There are several others under observation in test plantings, but not enough is known about them at present to include them in this list. The pistillate and staminate flowers are borne on separate plants. For fruit production it is therefore necessary that one staminate or male plant be included in each planting of several pistillate or female plants.

Dovyalis caffra

The kei apple, (*Dovyalis caffra*), is a native of South Africa, where it becomes a small tree. In Florida its development is usually that of a spready shrub. It has dark-green, glossy leaves and long spines on the trunk and branches.

The fruit has the shape of a small apple, one to one and a half inches in diameter, with a thin, tough skin, velvety to the touch and greenish yellow. The pulp is very juicy, acid, and aromatic. The ripe fruit makes a jam of a distinctive flavor, the immature fruits being used for making jelly.

The plant is hardy in southern Florida and withstands drought very well. It is rather productive and is adaptable to almost any soil condition that is not too wet. On account of its spiny stem and branches it would make an ideal protective hedge planting.

As a fruiting plant the kei apple requires frequent thinning out. It has a tendency to become too crowded in the center and full of unproductive shoots. It should be kept thinned out in order to allow a better circulation of air and sunlight throughout the top.

Dovyalis hebecarpa

The ketembilla, (*Dovyalis hebecarpa*), is a native of Ceylon. Like the kei apple, it becomes a tree under tropical conditions. In Florida its growth is more in the form of a large spready shrub; the leaves are light green and velvety when young.

The ketembilla is more productive that the kei apple and the fruits have a more general appeal. They are about an inch in diameter, round and slightly flattened at the flower end. The skin is velvety and of a purplish color when ripe. In general the fruit resembles a gooseberry. It is very acid, and makes an excellent jelly to be served with meat or fish.

The plant is not so hardy as the kei apple and requires a richer soil for good development. The size and quality of the fruit is greatly in-

fluenced by the water supply during the development period. The plant is not very deep-rooting and for good results should be kept mulched. The top should be kept thinned out, as it has a tendency to overcrowding. The fruit is produced on the mature twigs, so that lateral branching should be encouraged, with a fairly open top. Under reasonably good conditions the plant is very productive.

According to Wester in "The Food Plants of the Philippines," an average analysis of the fruit shows the following percentages: Water, 89.81; fiber, 0.23; fats, 3.89; sugar, 5.15; ash, 0.63; protein, 0.17; carbohydrates, 0.12. Calories per kilo of food: 564.

Flacourtia

The various species of *Flacourtia* are small trees or shrubs, native of tropical Africa and Asia. The plants of this genus are dioecious and are more productive when planted in groups, or in close proximity, with one staminate plant for each group of pistillate plants.

It is possible, among the many variations naturally occurring among a number of seedling plants, that some plants with complete flowers will be found. If so, such a plant should be reproduced vegetatively. Sometimes a plant produces a few flowers of the opposite sex, but this is only an incidental occurrence. Of the fifteen to twenty species on record the following are of possible value in southern Florida plantings.

Flacourtia jangomas (*F. cataphracta*)

This species, more commonly known as *Flacourtia cataphracta,* forms sturdy, upright-growing shrubs in southern Florida. The stems and branches are very spiny. The upright-growing branches spread out somewhat with their own weight, making a graceful shrub. The species is a native of India and the Malay region. The fruit is round, about three-quarters of an inch in diameter, and russet-purple when ripe. The flesh is creamy white, firm, mildly acid, and of a pleasant flavor. The plant is very prolific and deserves more attention than it has so far received. It is quite hardy and not very particular as to soil conditions, provided the soil is not too wet. While it is fairly tolerant of dry conditions, it is like practically all other bush fruits in that the size and quality of the fruit depend largely on the well-being of the plant during the fruiting period. If it is allowed to suffer for lack of water the fruits become tough and bitter, and usually drop off should the dry spell be prolonged.

Some pruning is necessary in order to control the tendency to over-

crowding of the top. The strong shoots growing up into the top from the base of the stem should also be kept cut out.

Analysis of the fruit from the Philippines, according to Wester, shows the following percentages: Water, 78.28; protein, 0.03; sugars, 4.86; ash, 0.94; fats, 0.39; acidity, 1.16.

Flacourtia indica (*F. sepiaria* Roxb.)

Flacourtia indica is a spiny, arborescent shrub from the Philippines, where it is known as "bitungol." In its native habitat it reaches a height of fifteen to twenty feet. It has small, dark-green leaves. In Florida it makes a dense shrub, with a slightly drooping sweep to the young twigs.

The fruits are round, dark purple when ripe, and from one-half to three-quarters of an inch in diameter. They have a very agreeable flavor, the pulp being sweet and juicy and mildly acid; it is excellent for making pies.

The plant grows in dry locations in the Philippines and has done well in Florida. It appears to be very hardy and to be able to withstand dry conditions. It has fruited for several years in southern Florida and is quite prolific. The fruits hang along the underside of the mature twigs, so that pruning should be along the lines of encouraging side branching and restricting the tendency to overcrowding of the top.

Flacourtia inermis

The lovi-lovi (*Flacourtia inermis*) or louvi of the Malaya region, is an open-growing, medium-sized tree bearing clusters of flattish, round fruit the size of a small cherry. The fruits are dark red when ripe and vary greatly in quality and flavor, from sour to sweet.

At present this plant can only be considered as in the experimental stage for Florida.

Flacourtia euphlebia

The lanagon of the Philippines (*Flacourtia euphlebia*) is an arborescent shrub of fifteen to twenty feet in height.

The fruits are about three-quarters of an inch in diameter, roundish, dark purple, and smooth and shiny; the flavor is pleasantly sub-acid. Not enough is known about this fruit in Florida to justify its use outside of test plantings.

Flacourtia ramontchi

The governor's plum (*Flacourtia ramontchi*) is a native of tropical Africa. In southern Florida it forms a large shrub, and is very showy

with its dark glossy leaves. Botanically it is scarcely more than a form of *F. indica.*

The fruit is a round berry, sometimes somewhat flattish, dark purple to almost black when fully ripe. It is astringent unless thoroughly ripe, when it has very much the texture of a ripe plum. It averages about an inch in diameter, and is eaten as a fresh fruit without cooking.

The governor's plum deserves to be more widely planted than has been the case, both as an ornamental and as a fruiting plant. There is a great deal of variation in the size and quality of the fruit, and also in the productiveness of individual plants. So far the plants have been grown only from seed, but there is now sufficient material of several years' standing in southern Florida from which to select superior fruiting strains for vegetative propagation. Since the species is dioecious, one plant by itself is not apt to produce fruit unless there happens to be a staminate plant in the near neighborhood. Plants purchased for the home yard should be old enough to have flowered in order to distinguish the sex; otherwise the purchaser is apt to find himself with a preponderance of non-fruiting staminate plants. Grafted plants and plants grown from cuttings are now available.

The plant is not very particular as to soil. It grows equally well on deep sandy soils and on rocky soils. It is quite hardy in southern Florida and is fairly resistant to drought. It does, however, require sufficient water during the fruiting season to develop good fruits. Deficiency of water during this period will result in small, bitter fruits. On rich soils the plant tends to overgrow, to the detriment of fruit production. Pruning is sometimes necessary in order to keep the top thinned out.

Analysis of the fruit from the Philippine Islands, by Valenzuela and Wester shows the following percentages: Total solids, 33.75; moisture, 66.25; protein, 1.34; fats, 0.27; reducing sugars, 21.74; fiber, 1.40; other carbohydrates (by difference), 7.29; ash, 1.05. Calories per 100 grams: 129.70.

Flacourtia rukam

The rukam (*Flacourtia rukam*) is a native of the Philippines and the Malay Archipelago. It is a medium-sized tree with a very spiny trunk and branches. The leaves are larger than are those of most of the other species of *Flacourtia,* being from three to four inches long. The juicy fruit is dark purple when ripe, about an inch in diameter, the seeds are rather large for the size of the fruit.

The tree is quite hardy and grows well on poor soils, but cannot for the present be recommended for planting outside of experimental gar-

dens. It is not so desirable for home plantings as *Flacourtia jangomas*, *F. indica*, or *F. ramontchi*. Throughout the Malaya region the young, tender, dark-red leaves are eaten as a salad.

Analysis from the Philippine Islands, according to Valenzuela and Wester gives the following percentages: Total solids, 23.07; moisture, 76.93; protein, 1.72; fats, 1.26; reducing sugars, 4.32; fiber, 3.71; other carbohydrates, 11.29; ash, 0.77; acidity, 1.29. Calories per 100 grams: 82.80.

GUTTIFERAE

This family contains only three genera of interest to tropical pomology. These are *Garcinia, Mammea,* and *Rheedia, Garcinia* being important and consisting of many species, and *Rheedia* being of least importance and as yet only in the test stage of planting in Florida. The family contains about thirty-five genera, the species being chiefly tropical. Several species are valuable timber trees, and some produce a resinous gum.

Garcinia

The genus *Garcinia* is imperfectly known, there being well over two hundred species in tropical Asia, Africa and Malaysia. There is a great diversity among the species of *Garcinia* in growth form, in the foliage, in the flowers, and in the fruits, which may vary in shape, quality, and color. The best-known and practically the only species with fruits of commercial value at present is the famous mangosteen of tropical Asia.

There are several other species in test plantings, and while several of them give promise of successful development, *Garcinia* may be considered for the present as being in the early experimental stage in southern Florida, with the possible exception of *Garcinia livingstonei;* a few specimens of this species have successfully matured several crops.

The gamboge tree (*Garcinia morella*) yields a resinous juice, the pigment gamboge. It has been partially successful in southern Florida.

The mangosteen (*Garcinia mangostana*), the most famous species of the genus is justly considered by many connoisseurs to be the most delicious fruit in the world. It is strictly a tropical tree requiring a year-round moist, warm climate, and there is not much hope of its ever being successfully grown in southern Florida. It flourishes throughout the eastern tropics and is now becoming established in several of the West Indian islands and in Central America.

Garcinia livingstonei has been mentioned as a successful root-stock for the mangosteen. This species has proved adaptable to southern

Florida, but so far as is known it has not been tested here with grafts of the mangosteen. *G. tinctoria* has also been reported as a compatible root-stock, but this species is not so hardy as *G. livingstonei.*

Garcinia tinctoria very much resembles the mangosteen in color of foliage and general habit, but is not very closely allied to the latter. It produces a thin-skinned, yellow fruit about the size of a peach. The soft flesh of the ripe fruit is pleasantly acid. It is a dessert fruit and is best eaten fresh, being very good with sugar and cream. The pulp may also be used in sherbets. Partly ripe fruits may be used for making paste. The tree is quite successfully grown in Cuba, and while several young specimens are making good development in southern Florida, there is no record of fruiting trees so far.

Garcinia livingstonei is quite hardy and is successful on the sandy and rocky soils of southern Florida. A few of the earlier planted trees have fruited well. The trees that have fruited so far may be of a poor seed strain; the fruits have been much smaller than expected and of poor quality. The fruit cannot be considered to be of much economic value, the seed being much too large for the size of the fruit. There appears to be much variation among specimens of this species. It is to be hoped that some of the younger trees may produce fruit of better quality when they come to bearing age.

Garcinia spicata is an upright-growing evergreen tree with dark-green, roundish, leathery leaves. It is more of an ornamental than an economic tree. In southern Florida it is making satisfactory growth in both the deep sandy and the rocky soils. It has proved to be quite storm-resistant and is apparently quite resistant to salt spray.

Mammea

Mammea americana, the mammea apple or mamey de Santo Domingo, is indigenous to the West Indies and tropical America. It is a large tree of upright growth, reaching a height of fifty or sixty feet in favorable conditions, and is very striking with its glossy, dark-green leaves.

The fruit is round, six to eight inches in diameter, with a rough, leathery, russet skin. The flesh is firm and solid and pale yellow. The fruit usually contains two or three large, rough, brownish seeds.

The ripe fruit may be eaten out of hand or sliced and served with sugar and cream. It makes an excellent sauce, but loses its flavor if cooked very long. The fully grown green fruits are very high in pectin content and make a firm, clear jelly; the addition of acid is necessary, however, to release the pectin in cooking. As the fruit loses its flavor

through cooking, it is very useful in combination with acid-low pectin fruits. Pineapple and mammea together make a firm, clear pineapple-flavored jelly.

The mammea is successful in southern Florida but does best in rich humus soils. There is much variation in fruit productivity among seedling trees and also in the quality of the fruits. Varying considerably in texture, color, and flavor, it is a promising fruit for selection and vegetative propagation.

Analysis from Cuba, according to Cardenas and Moreno, shows the following average of several samples by percentages: Water, 84.00; protein, 0.48; fats, 0.30; sugars, 9.50; starches, 1.03; fiber, 3.90; acidity, 0.39; ash, 0.40. Coefficient of digestibility: protein, 80.00; fats, 96.00; carbohydrates, 90.00.

LAURACEAE

To this group belong the well-known clove, cinnamon, camphor, bay laurel, and sassafras. While the camphor, cinnamon and the clove are of economic importance in tropical horticulture, our chief interest in the present discussion is with the genus *Persea,* to which genus the avocado or alligator pear belongs.

Persea

The avocado was perhaps one of the earliest food items in the diet of tropical American aborigines. The Incas of Peru and the Aztecs domesticated wild plants and improved them through selection and cultivation. There are three main strains or types of the avocado as cultivated at the present time; until recently these were classified as distinct species.

Persea americana, commonly known as the West Indian avocado, is indigenous to the lowlands of tropical America. It is the more commonly known summer-fruiting type, with a smooth, leathery skin. There is much variation in color, ranging from pale green to purple when ripe. The flesh varies from very soft and watery to a dry, nutty consistency, and the shape varies from round to bottle-shaped with a long thin neck. The round, greenish fruits generally have a dry, nutty flavor; the long bottle-shaped, purple type is usually inclined to be soft and watery-fleshed.

The Guatemalan avocado, winter- and spring-fruiting, is classed as a sub-type of the West Indian species. The skin of the fruit is rough and brittle, and much thicker than that of the West Indian or Mexican plant. In growth and foliage, it resembles the Mexican species, the leaves, however, are not anise-scented.

Persea drymifolia, the Mexican avocado, from the higher lands of Mexico is a winter- and spring-fruiting species. The leaves are anise-scented and the fruit has a soft, thin shell. There are several species and types not completely classified and of little commercial importance at present, although future work may require them for breeding purposes in developing special strains.

The Guatemalan and Mexican avocadoes have developed naturally under high-altitude conditions, and as such have not been very successful under the sea-level conditions of southern Florida. A few varieties of both types have fruited fairly well but cannot be considered to be commercially valuable. The Guatemalan avocado has proved more adaptable to Florida than the Mexican, while the latter has been more successful in California. The outstanding Guatemalan varieties in Florida are the Linda, Macdonald, Taft, Taylor, and Wagner.

Numerous West Indian varieties have appeared from time to time, but most of them have not succeeded under our actual growing conditions. The more successful of them are the Pollock, Simmonds, Trapp, and Waldin.

Many hybrids have originated in Florida through cross-pollination of the Guatemalan and West Indian types. On the average these hybrids are vigorous growers, and several of them are quite prolific, with good-quality fruit. There is naturally a great diversity in general characteristics, so that a good selection should be possible. The fruiting period is on the average later than that of the West Indian type and earlier than that of the pure Guatemalan. A large number of these hybrids are being tested under practical conditions, and some definite selections are to be expected in the near future. At present the two most outstanding varieties are the Collinson and the Winslowson.

The Lulu is an interesting hybrid, being an exception to the general rule. According to its characteristics it is a cross between the Guatemalan and the Mexican types. It is quite successful in southern Florida, and being exceptionally hardy, it should prove adaptable to conditions farther north in the state.

An unusual development of the avocado flowers affects the pollination and subsequent setting of the fruit. The flowers are complete; that is, they have the requisite pistil and pollen-bearing stamens for the formation of a complete reproducing flower, yet they are practically self-sterile. As a result of investigation of this peculiarity the varieties have been separated into two groups, A and B. In class A the pistils are receptive to pollen during the forenoon, at which time the pollen from the same flowers is not yet ready for shedding; during the after-

noon the pollen is ripe and shedding, by which time the pistils have passed the receptive stage. In class B the periods of maturity of the pistils and stamens are in reverse to those of class A. In plantings of seedling trees the natural average of A and B trees usually takes care of the situation, but in planting budded trees of distinct varieties it is necessary to have a mixture of the two classes for successful pollination. Among the varieties at present offered for sale there is a natural variation in the selection of reciprocating varieties, as an early-flowering A would be of no value to a late-flowering B; both would fail to set fruit. Bulletins are available from the Agricultural Experiment Station at Gainesville, Florida, for those interested in studying the subject further with a view to establishing commercial plantings. For the homeowner wishing to plant a few trees for home use, the following list of desirable varieties will suffice:

Class A:		
Collinson	Hybrid	Late flowering
Lulu	Hybrid	Midseason
Simmonds	West Indian	Midseason
Taft	Guatemalan	Midseason
Taylor	Guatemalan	Midseason
Wagner	Guatemalan	Midseason
Waldin	West Indian	Midseason
Class B:		
Linda	Guatemalan	Midseason
Macdonald	Guatemalan	Late
Pollock	West Indian	Early
Trapp	West Indian	Midseason
Winslowson	Hybrid	Midseason

The flowering seasons cannot be distinctly divided, as there is always an overlapping, and weather conditions influence the maturity of the flowers. As avocado flowers are pollinated chiefly through the agency of bees, it is therefore unnecessary to plant the classes in close proximity.

The Collinson should be planted only where some other Class A variety is included. It has the peculiarity of not maturing pollen, and cannot reciprocate in an interchange of pollen with Class B varieties. It is an excellent fruit and should be included in mixed plantings wherever possible, but should be accompanied by another Class A variety for the pollination of the Class B varieties.

The avocado has possibilities of becoming one of the staple foods of

the future for the temperate zone, as it now is for the tropics, especially with the development of the winter fruiting varieties. Its richness in food elements and high producing qualities make it a fruit of great potential value. For commercial production there are still many problems to be solved, but for home plantings simple, common-sense cultural methods will suffice. There is confusion for the amateur among the numerous types and varieties at present offered for sale, as a result of the first great influx of hybrid seedlings. The next few years should see this question fairly well-straightened out; at present a few varieties stand out from the rest in one characteristic or another. In the field of hardiness, resistance to diseases, and quality of fruit there is still much to be done, but these are problems for commercial orchardizing and for the plant breeder rather than for home plantings.

At present the avocado is considered chiefly a salad fruit. Its protein and fat content is high, and it is rich in vitamins. There is much divergence between the analyses of the fruit, even within a given variety. Analysis, given by Stall of the Florida Agricultural Experiment Station, shows the following percentages:

	Edible Pulp	Oil, Wet Basis	Sugar	Protein	Ash
Wagner	64.00	23.00	1.90	1.20	1.20
Trapp	75.00	11.00	1.60	1.30	1.00
Waldin	68.00	7.00	1.40	1.20	1.10
Collinson	80.00	11.00	1.70	1.20	1.30
Lulu	68.00	17.00	1.90	1.60	1.80

Cardenas and Moreno give analyses from Cuba of the two common West Indian types, taking an average of several fruits the following percentages indicated:

Green type: Water, 71.00; protein, 1.71; fats, 20.90; sugars, 1.15; other carbohydrates, 2.31; fiber, 1.60; ash, 1.33. Coefficient of digestibility: Protein, 84.00; fats, 91.00; carbohydrates, 93.00.

Purple type: Water, 73.50; protein, 2.00; fats, 18.00; sugars, 1.55; other carbohydrates, 1.60; fiber, 2.10; ash, 1.25. Coefficient of digestibility: Protein, 84.00; fats, 91.00; carbohydrates, 93.00.

The avocado does fairly well on any well-drained soil, preferring rich humus soils with a good mineral content. On deep sandy soils the fertility must be built up in order to obtain good results. On such soils the trees have a good color and seldom suffer for lack of moisture after

getting their taproots down into the yellow-sand substratum. They flower well but fail to set a good crop of fruit, and usually the fruits which do set develop poorly. Irrigation is advisable at the flowering stage, and at intervals as the fruit is developing. Building up a humus soil for the surface feed roots by heavy mulching is necessary, as are frequent light applications of commercial fertilizer. On the rocky soils of Dade County mulching is even more necessary. The flatwood soils require drainage for avocadoes; high ridges and free-flowing sub-ditches are essential.

Pruning is advisable in order to keep the tree-tops open and to control any sprawly growth. Late-fruiting varieties should be kept low and spready in order to minimize damage from fall winds, and windbreaks are positively necessary for large plantings.

With some of these new varieties there is a danger of over-fruiting, especially when the trees are young. This is bad for young trees and may cause them to drop their crop, and to become stunted to such an extent that they will not set fruit again for several years. Avocado trees readily become bark-bound if allowed to become too dry or as the result of severe cold spells. Slitting the bark is the quickest method of relieving this condition; the operation should be accompanied by irrigation and an application of quickly available nitrogen.

LEGUMINOSAE

The bean family is a very large plant group, comprising herbs, vines, shrubs and trees. Of the tropical trees and shrubs, many may be classed as ornamental or timber-producers. While the pods of many leguminous trees are used as food by human beings in various parts of the world, they have not sufficient value to admit their use in our American diet.

There is a fair list of borderline species; that is those considered to be of food value in certain localities but not in others, this condition being influenced chiefly by the amount of other foods available to local residents. The genus *Inga* contains two outstanding species, *Inga feuillei* of Peru and *I. inicuil* of Panama, the pods of which have sweet, edible pulp much relished in their respective countries. The genus *Pithecellobium* (*Pithecolobium*) has several semi-economic species. *Pithecellobium dulce* of Mexico has a sweet, white, dryish aril surrounding the seeds. *Samanea* (*Pithecellobium*) *saman* of the West Indies has a sweet, locust-like pod. *Prosopsis juliflora* is the mesquite of Mexico. *P. pubescens,* the screw bean or tornillo, also of Mexico, has edible pods, eaten by cattle and often used by Indians.

For the present purpose the two important genera of the family Leguminosae are *Ceratonia* and *Tamarindus*. Both have been used since earliest times as important articles of commerce wherever they can be successfully grown.

Ceratonia

The carob or St. John's bread (*Ceratonia siliqua*) is a spready-growing evergreen tree, native of the Mediterranean region, and used for its sweet edible pods. While there is only one species, many varieties are now recognized and the better ones are being reproduced by budding.

It is supposedly the husks of these pods that were eaten by the prodigal son. The carob is a valuable crop throughout the Mediterranean region, the pods being exported to Europe, where they are used as cattle feed. They are also extensively used as human food in the regions where they are grown. The large pods are high in protein and sugar, with a high digestive coefficient and nutritive value. A very good syrup is made from the ripe pods, and for this reason it may be considered to be of interest as an economic plant for southern Florida.

The tree is quite successful in Florida, and occasionally a large fruiting specimen is to be found. In recent years much progress has been made in California with the selection of better varieties; so far very little has been done with it in Florida. The tree grows well on dry soils and does not seem to require special care.

In "The Food Plants of the Philippines," Wester gives the following analysis by percentages: Pods (without seeds): Water, 12.50; ash, 2.30; fiber, 9.40; protein, 2.10; fat, 0.40; carbohydrates, 42.05; sugar, 31.25. Calories per kilo of food: 3051.

Tamarindus

The tamarind (*Tamarindus indica*) is one of the most useful of the tropical trees. It is an ornamental evergree tree, attaining large size, with fine, attractive foliage. Its hard fine-grained wood is excellent for cabinet work. As a fruit tree, it is one of the important trees of Asia.

The pods are from three to six inches long, and sometimes longer. They are slightly flattened, about one inch wide and are usually slightly curved. They are greenish gray, turning brown when ripe, at which time the shell becomes dry and brittle. A few strong fibers run the length of the pod just beneath the shell, holding the mass of soft pulp and seeds together. The soft, brown pulp of the fruit is granular, and

is at the same time the sweetest and sourest of fruits, being very high in both sugar and tartaric acid.

Paste made from the pulp has been a commercial commodity in the eastern tropics since earliest times. A brine made from the pulp is used in India and Ceylon for pickling fish. Tamarind "ade" is a well-known refreshing drink having medicinal properties. It is antiscorbutic and a good blood-purifier. An acid jelly very suitable for serving with fish or cold meats can be made from the ripe fruits. In the Dutch East Indies the green fruits and twigs are used in many ways, principally as flavoring for meat and vegetables. Throughout Asia the tender leaves have an accepted value for poultices and fomentations.

The tamarind tree is quite adaptable to southern Florida conditions. Many old trees are to be found in the earlier homestead plantings, but apparently very little attention has been given to it in recent times. This is surprising, because it is one of the most useful fruits we could possibly grow. The tree is very resistant to winds and is recommended in the tropics as a windbreak. In southern Florida it is of relatively slow growth, but it thrives and fruits quite well on rocky soils, although it prefers deeper moist soils. The young plants are tender, but the mature trees are quite hardy. While there is only one species, there are several different recognized types, their fruits varying in size and in flavor. In Florida the time of ripening is usually April and May.

The following analysis, by percentages, of ripe tamarind fruit is given by Cardenas and Moreno in Cuba as: Water, 40.00; fats, 0.97; starches, 4.00; acid (tartaric), 12.20; protein, 2.28; sugars, 31.65; fiber, 7.40; ash, 1.50. Coefficient of digestibility: Protein, 84.00; fats, 97.00; starches, 87.00.

MALPIGHIACEAE

The family Malpighiaceae contains over fifty genera, mostly of tropical America, some of which are grown as ornamentals. One genus, *Byrsonima,* has several species with high tannin content in the bark, which is used in tanning. *Byrsonima crassifolia* of western Mexico produces a sour fruit used by the Indians; the bark is also used medicinally.

Malpighia is the only genus of this family group having fruits of economic importance of interest at the present moment for southern Florida. There are some forty species throughout tropical America, most of them with small, insignificant fruits of little importance.

Malpighia punicifolia, the Barbados cherry, from Central America and the West Indies, is a large, strong-growing bush reaching a height of ten to twelve feet. By pruning the lower stems it can be grown as a

small tree. It has a spready growth with slender branches. The bush usually fruits twice a year, in the late spring and the early fall. The fruits are red, turning purplish when fully ripe, are from three-quarters to one inch in diameter, and are borne in clusters on the mature twigs. They are slightly fluted, being very similar in size and shape to the Surinam cherry. They are extremely acid until fully ripe, and have a thin skin and juicy, aromatic flesh. This fruit makes very good jelly, jam, and wine.

There are several fruiting bushes in southern Florida, but the species is not highly successful on thin sandy or rocky soils without special care. It is very intolerant of alkaline soil but quite susceptible to nematode infection. It is well worth the trouble to provide the proper conditions for this desirable fruiting plant; a large hole filled with rich earth or decomposed trash makes an ideal place for it. While the nematode affects the small plants, serious injury may be anticipated by providing proper plant food for with reasonably good feeding and sufficient water the plants will soon send their main feed roots beyond the depth of the nematode-infested area.

Periodic pruning in order to thin out the crowding growth from the center of the bush is advisable. While the plant may be pruned into tree form, larger and better fruits are produced on the bush form, where the growth can be kept in the proper vigorous state by pruning. The fruits are apt to be bitter should the plant suffer from lack of water during the fruit-development stage, and lack of water at the time of flowering and setting fruit will cause the young fruits to drop. The plants are tender when young, but become fairly hardy on developing woody growth. The following analysis data in percentages is taken from Wester's "The Food Plants of the Philippines": Waste, 8.35; water, 92.10; ash, 0.62; protein, 0.21; sugar, 2.44; acidity, 1.39.

Another species of *Malpighia,* native to Mexico and the West Indies, is a small shrub of upright growth, with slender stems and branches. The leaves are smaller and more sharply pointed than are those of the Barbados cherry. The fruits are about a quarter of an inch in diameter, dryish and insipid. This plant is at present used as an ornamental. It is of interest in the present case on account of its tolerance of sandy-alkaline soil conditions. It may prove of value as a root-stock for the Barbados cherry or for hybridization with it, in an effort to reduce the high acidity of the fruit of the latter and to give some tolerance of lime soils to the plant.

Malpighia cubensis, M. urens, and *M. suberosa,* are hardy-growing, small-fruited prolific species, native to the West Indies, and appear to

grow quite well on alkaline soils. They are at present under observation in test plantings in Florida and may prove to be of value as nematode resistant root-stocks.

MORACEAE

The family Moraceae consists of over fifty genera, some representatives of which are grown chiefly as ornamentals. It has several genera of high economic value such as *Morus* (mulberry), *Ficus* (fig and India rubber trees), *Humulus* (hop), and *Cannabis* (Indian hemp). *Antiaris* is another genus of this family, its most interesting species being *Antiaris toxicaria,* the Upas tree of Malaya, which according to ancient travelers' tales is so poisonous that people coming to within a short distance of it are affected by the poison, and anyone sleeping under it dies; this myth has, however, been exploded, although its milky sap is very poisonous.

The three genera of interest here are *Artocarpus,* to which the breadfruit belongs, *Ficus,* and *Morus.*

Artocarpus

The genus *Artocarpus* contains some thirty-five to forty species, some with edible fruits, all natives of the Old World tropics. Some of them are of distinct economic value to the natives in the regions where they grow. A few are being tried out in test plantings, but at present only two species are of interest to us, *Artocarpus communis* (*A. incisa*), the breadfruit, and *A. heterophylla* (*A. integra, A. integrifolia*), the jak.

Artocarpus communis (*A. incisa*), the breadfruit, is a tree reaching to a height of thirty to forty feet in the tropics proper. The leaves are leathery, and sometimes grow as large as three feet long, with long lateral lobes. It is a handsome tree, with a truly tropical aspect. The fruit is round, with a diameter of six to eight inches, some forms being somewhat elongated and from eight to twelve inches in length, with a rough, knobby skin. The fruit has a fibrous core with the large, nut-like seeds embedded in a whitish, flaky, sponge-like pulp, certain forms being seedless. Some of the varieties may be eaten raw, but they are generally baked, boiled, or roasted; the seeds are roasted and eaten as nuts. A starchy flour is made by drying and grinding the pulp. There are two recognized types, the seedless, the finer and more valuable of the two, and the seed-bearing one.

The breadfruit is one of the most important food fruits of the Polynesian region. Through years of cultivation many varieties have been developed which are held in great esteem, particularly in Polynesia.

The tree is quite tender, and there appears to be no hope of its becoming generally established in southern Florida. It may possibly be grown under special conditions where it can be protected from cold winds and occasional frosts. In Cuba the tree has been known to drop its leaves at 45° F.

The following analysis of the seedless breadfruit, by percentages, is given in the Annual Report, Hawaii Agricultural Experiment Station, 1914: Waste, 22.25; water, 58.18; ash, 0.95; fiber, 1.20; protein, 1.57; fat, 0.19; carbohydrates, 27.89; sugar, 9.49; acidity, 0.05. Calories per kilo of food: 1574.

*Artocarpus heterophylla** (*A. integra, A. integrifolia*), the jak fruit or jaka, is an evergreen tree reaching a height of thirty to thirty-five feet; the leaves are dark, glossy green and about six inches long.

The fruit is one of the largest borne by any tree; it ranges from twelve to twenty inches long and from eight to ten inches thick; in weight it varies from twenty to thirty pounds, but in tropical Asia some varieties produce fruits attaining a weight of seventy-five to eighty pounds. The soft, whitish pulp contains numerous large, nut-like seeds which constitute a valuable part of the fruit. The pulp is cooked and eaten by the poorer classes in cases of necessity, and is sometimes used in making preserves. The roasted seeds are a valuable food, and are much relished throughout the tropics.

There are numerous varieties in tropical Asia. These show great variation in quality. There are two general types of jak, one with a soft rind, the other with a hard, melon-like one. The fruits are borne on the main limbs and on the tree trunks.

The tree requires a rich soil and plenty of water. It is hardier than the breadfruit, and several trees have borne fruit in southern Florida.

Wester quotes the following analysis by percentages: *Pulp:* Waste, 68.00; water, 81.08; protein, 1.44; fat, 0.45; sugar, 15.15. *Seeds:* Waste, 13.00; water, 49.18; ash, 3.49; protein, 5.44; fat, 0.24; carbohydrates, 23.53; sugar, 1.87; acidity, 0.16. Calories per kilo of food: *Pulp:* 704. *Seeds:* 1255.

Artocarpus odoratissima is a species from the Philippine Islands. The fruit somewhat resembles that of the breadfruit, is smaller and of superior quality. It has been tested in Florida, but has not been suc-

*For about 160 years this species was universally known as *Artocarpus integrifolia*, and in more recent times as *A. integra*, through a consistent misinterpretation of the original description. It has recently been shown that *Artocarpus integra* is the proper name for the entirely different champeden of the Malayan region, long known as *Artocarpus polyphema*. The proper name for the jak is *Artocarpus heterophylla*.

cessful; it is quite tender. The tree has large, dark-green leaves from twelve to twenty inches long, generally lobed. The fruit is oblong, about six inches long, the surface dotted with fleshy spines; the pulp is sweet, juicy and aromatic.

Ficus

The genus *Ficus* contains over six hundred species, including trees, shrubs, and climbers. One of the most famous of the *Ficus* trees is the banyan tree of India (*Ficus benghalensis*), which throws down aerial roots from the branches to form new trunks. The common ornamental rubber plant (*Ficus elastica*), so much used as a house plant throughout the United States, is one of the most commonly known species. *Ficus sycomorus,* Pharaoh's fig of Biblical mention, bears edible fruit. It is a large tree and bears its fruit on the trunk and branches. It has been grown quite successfully in southern Florida. The fruits are not of wide commercial value, but are sometimes used for home cooking.

The only species bearing fruit of commercial value is *Ficus carica,* the true fig; although not strictly a tropical fruit it can be grown successfully in southern Florida.

The chief drawback to growing figs in this region has been the nematode infection so prevalent in light sandy soils. Within the past few years a nematode-resistant species, successful as a root-stock for the fig has been tried out with good results, thus making fig-growing possible here.

Climatic conditions in southern Florida are not suitable for commercial fig-growing in competition with the regular fig-growing sections of the United States, but as a home-yard tree it may now be considered possible here in southern Florida. The fig tree prefers a heavy clay soil, but with good feeding and mulching it may be grown on sandy and rocky soils. Good fruiting specimens of Brown Turkey, Brunswick, Celeste, and Lemon are to be found on some of the earlier homesteads, especially in the Homestead and Redlands districts.

The following analysis is given by the United States Department of Agriculture as an average for figs, the data in percentages: Water, 78.00; protein, 1.40; fat, 0.40; ash, 0.64; carbohydrates, 19.60; fiber, 1.70; sugars, 16.20; acid, 0.17. Calories of fuel value per 100 grams, 87.6; per pound, 395.0.

Morus

The mulberry is not a tropical fruit. Its place is in the temperate zone, but it can be grown fairly well in southern Florida. In the earlier

days of the homesteads several varieties were brought here from the North. These were favorites in their northern localities, and it was hoped that they would be successful in Florida. It is a commonly accepted theory that the large fruiting mulberry varieties revert or degenerate, producing after a few years in this climate only small, poor fruits. After an especially long or cold winter season they usually produce very good fruit, perhaps not as large as that of the same variety in the North, but better than average. The reason for the small, poorly developed fruit lies in the fact that the trees do not have a thorough dormant period; they have long been accustomed to a dormant period each year, breaking out in the spring with renewed vigor. A proper pruning before the spring rains begin will go a long way toward helping the tree produce larger fruit. The mulberry is not particular as to soils; trees may be seen in all types of soil in southern Florida, with the exception of water-logged soil.

There are three outstanding species of *Morus;* many of the other so-called species may be sub-species or simply varieties. Their proper classification is confused.

Morus alba, the white mulberry, originated in China, where certain varieties are grown specially for feeding silkworms. There are several commercial fruiting varieties of this species in the United States.

Morus nigra, the black mulberry, of Asiatic origin, is the chief fruiting species; there are many commercial varieties.

Morus rubra, the red mulberry, is native to North America and grows wild in many places in the United States, especially in the southeastern states. There are several commercial varieties.

The United States Department of Agriculture gives the following analysis as an average for mulberries, data in percentages: Water, 82.08; protein, 1.02; fats, 0.06; ash, 0.84; carbohydrates, 14.06; fiber, 2.00; sugars, 9.04; acid (malic), 0.95. Calories of fuel value per 100 grams, 68.6; per pound, 310.0.

MUSACEAE

The Musaceae is distinctly a showy family of plants, including *Musa* (the banana), one of the most important food-producing plants. *Strelitzia,* a genus or several species, is famous for its *S. reginae,* the bird-of-paradise flower, especially prized on account of its bright orange-and purple-colored, bird-shaped flowers. *Ravenala madagascariensis* is the striking and highly decorative traveler's palm, utilized as a source of drinking water for travelers in Madagascar, where it is native. *Heliconia* contains several species grown for their highly decorative leaves and

fruiting bracts. *Musa* is the only genus of this family producing edible fruits of commercial value, and is therefore the only one in which we are at present interested.

Musa

Musa is possibly the most valuable genus of tropical fruiting plants. There is a long list of species and varieties, all natives of the Old World tropics, only a few of which need be mentioned here. In the Indo-Malaysian region there are scores of varieties recognized by the natives under distinctive names.

Many of the species are grown purely as ornamental plants, their large leaves and general character being appropriate for certain plantings, notably in patios and in conservatories. *Musa textilis,* the abaca or Manila hemp plant, is grown extensively in the Philippine Islands as a fiber plant, the fiber being used in the manufacture of rope.

Musa paradisiaca, the plantain or cooking banana, is perhaps more important than the sweet banana in the diet of the natives of tropical countries. This species is hardier and more adaptable to varying conditions than is the common banana and it is therefore more widespread. The sweet banana is supposedly of more recent development than the plantain, and was probably derived from the latter. There are numerous types of plantain throughout the tropics, each locality having its own favorites, according to their suitability to local conditions.

In the West Indies there are three types in common use, the macho, the hembra, and the burro. The macho is the best of the three, the hembra is smaller and very similar, while the burro is decidedly inferior in quality. The fruit of the plantain is larger than that of the average sweet banana, the skin is thick and stiff, and the fruit has a sharply tapering base and tip. The fruits may range from eight to twelve inches long; the bunches are not large, usually having four or five open, spready hands.

The fully grown fruit, peeled and sliced into thin wafers and fried in deep fat like Saratoga chips, is served in place of bread in many rural homes throughout Cuba. Allowed to ripen thoroughly, peeled, and sliced lengthwise and fried, the fruit makes a very pleasant and nutritious addition to the menu. Ripe fruits may be roasted or boiled in their skins, peeled, and eaten with salt or sugar.

Flour made from the plantain fruit is considered one of the best foods for invalids and children. It is recognized in hospital diatetics as also having certain beneficial influences on the intestinal tract.

Musa cavendishii, the Chinese or dwarf banana, is quite common

throughout the West Indies. It is the hardiest of the bananas and has proved to be very adaptable to conditions in southern Florida.

The fruit is small, thin-skinned, and sweet. In Florida it spots readily and does not have a good market appearance. It does not ship well. This is, however, the hardiest and most suitable of the bananas for home plantings in southern Florida.

The plant is of dwarf growth, with a short, stout stem and a dense head of short, broad leaves. It is more resistant to wind than the other species and does not require special protection. It is also more suitable to light sandy soils but must have a plentiful supply of moisture. It is unfortunate that so many plantings of this banana have been made on dry soils. The species is grown in the Canary Islands, there constituting one of the major industries, the fruit being exported to Europe.

Musa sapientum, the common or sweet banana, is exceedingly variable in its fruit characters, scores of forms being recognized by the natives of the Old World tropics under definite and constantly used local names.

In the commercial plantings of tropical America and the West Indies, much damage has been done by the wilt disease, the problem being to find a good market type resistant to this disease. In scattered small plantings outside of areas of commercial production the disease is not very prevalent. In Cuba practically every farm and home yard has its clumps of bananas, both the cooking and eating kinds; of the sweet *Musa sapientum,* the varieties mostly grown are the manzano or apple banana, the red banana, and the date banana.

The manzano, or apple banana, may be rated as a second-class type, but it is hardy and prolific, serving well the requirements of a small home planting; besides, it is successful in conditions where the large first-class types would not thrive. The plant is of medium size, the bunches are small, and the short, plump fruits have a slight apple aroma when ripe. Cardenas and Moreno give the following analysis, by percentages, for this fruit as grown in Cuba: Water, 69.00; protein, 1.15; fats, 0.59; sugars, 21.40; carbohydrates, 5.50; fiber, 1.25; acidity, 0.30; ash, 0.90. Coefficient of digestibility: Protein, 80.0; fats, 98.0; carbohydrates, 90.0.

The Colorado, morado, or red banana (*Musa sapientum rubra*) is not a distinct species but is a sub-species of *M. sapientum.* There are several types recognized locally by name.

The red banana is a tall, strong-growing plant, with a reddish stem and red midribs in the leaf. The fruits average six inches in length and are round, cylindric, and plump, with a thick dark-red or purplish skin, becoming lighter in color as the fruit ripens; the bunches are medium in size, bearing from four to six hands of fruit.

This is not a strictly dessert fruit, and is best when baked or roasted. Cardenas and Moreno give the following analysis by percentages: Water, 75.60; protein, 1.19; fats, 0.31; sugars, 16.40; carbohydrates, 3.60; fiber, 1.80; acidity, 0.25; ash, 0.85. Coefficient of digestibility: Protein, 76.0; fats, 98.0; carbohydrates, 85.0.

The datis, or date banana, produces a small, very sweet fruit and is a general favorite throughout the West Indies. It is a slender-stemmed, dwarf type and is quite prolific. The fruits are excellent for eating out of hand; the ripe fruits split and fried are delicious.

Bananas require a rich, moist soil and are not at all tolerant of lime-soil conditions. For this reason most of the home plantings in southern Florida have failed to thrive. On account of the large, tender leaves, which split readily when the plant is exposed to wind, a protected location is necessary. An out-of-the-way corner in a sunken pit, where decomposed plant material has been allowed to accumulate, is the best place; provision should be made to supply abundant water, taking care at the same time to provide proper drainage.

The partly ripe fruit of the banana, even though yellow in color, is quite indigestible. When fully ripe, the starch of the banana is more readily digested than is that of the cereals; the best stage for eating is when the skin begins to show spotting.

In the tropics the fruit is often dried and ground into flour; a mixture of banana and wheat flour is excellent for baking purposes.

Southern Florida is not a commercial banana-producing region; the humidity is not sufficiently high for the large, succulent market types, while the winter months are too dry. In an average winter season the weather is too cool for the successful development of commercial plantings. For home plantings, the large, tender Johnson type is not apt to be successful except in a very few special locations. The hardier second-class types are more to be recommended, although the Cavendish is the only really successful one for all-round planting; it is more adaptable to southern Florida than any of the other sweet bananas. The plantain is hardy enough for home plantings, but requires protection from the wind on account of its tall, slender growth and long leaves.

MYRTACEAE

For variety and for possibilities for the future development of excellent fruits through plant-breeding, the fruiting trees and shrubs of the Myrtaceae are undoubtedly the most interesting. Many representatives of this family bear flavorsome fruits, and many of them also have aromatic, spicy leaves.

Among the ornamental plants of this family, the most widely known in southern Florida are the *Eucalyptus*, the *Callistemon* (bottle brush), the *Melaleuca* (cajuput), and *Myrtus* (myrtle), of which one species, *Myrtus communis,* is the myrtle of the classics.

The commercially important species belonging to this family are the allspice (*Pimenta officinalis*) and the clove (*Eugenia aromatica*); the *Eucalyptus* and the *Melaleuca* also yield aromatic oils used in medicine. The West Indian bay rum tree (*Pimenta acris*) also belongs to this family.

Eugenia and *Psidium* are the two genera of most importance to southern Florida, both in number of species and in economic value, from the standpoint of fruit production.

Eugenia

Eugenia is a very large genus containing numerous worth while trees and shrubs of ornamental value; a few species yield wood of commercial value, while a considerable number of them have edible fruits, some of which are of economic importance.

A large number of species of *Eugenia* are to be found in test plantings, many of which may prove to be of value, although a large number of them bear small, dry fruits, and a few appear to be too tender for climatic conditions in Florida.

Eugenia cumini

Eugenia cumini (*Syzygium cumini, Eugenia jambolana*), the duhat of the Philippines, is a strong, tall-growing tree of stately appearance. There are several fruiting trees in southern Florida at present about thirty feet tall. The leaves are oval and shiny, from four to six inches in length, and about two inches in width. They are of a medium green, and blend well with the light-gray bark of the trunk and branches. The duhat is very attractive as an ornamental and shade tree, and is quite adaptable to dry soils.

The oval fruit, about one inch long, is black when ripe. The fruit clusters on the mature twigs look like small clusters of grapes; the pulp is purple and of a sweet, mildly-acid flavor. Full-grown fruits just beginning to color make an excellent rich colored jelly. As the tree has generally been grown from seed, there is much variation in size and quality of the fruit, a seedless type having been reported from the Philippines. The trees which have fruited so far in Florida are not of very high quality; some of the more recent introductions are supposedly of

a larger-fruiting type. Propagation of good types will necessarily have to be effected by budding or grafting.

The tree appears to be quite hardy in southern Florida after woody tissues have been formed. It is suitable for rocky places as well as deep sandy soils. After becoming established the tree is quite resistant to drought and no special pruning or cultural requirements appear to be necessary.

Wester quotes the following analysis from the Philippines, by percentages: Waste, 25.00; water, 80.80; ash, 0.70; protein, 0.81; sugar, 12.70; acidity (sulfuric), 0.63; acidity (malic), 0.88.

Eugenia curranii

Eugenia curranii, the lipote of the Philippines, is an upright-growing, slightly spready-topped tree of medium height. A tree which has been fruiting in southern Florida for several years is now about twenty feet tall.

The oval leaves, about six inches long, are medium green when mature; the young leaves have a deep wine color, making a beautiful showing as the tree bursts into new growth. The grayish bark of the trunk and older branches resembles that of the common guava.

The small, round fruits, about half an inch in diameter, are black when ripe, being borne in clusters on the mature twigs. The pulp is mildly acid and of a very attractive flavor, but is likely to be too dry for eating out of hand. The fruit is high in pectin and makes a very agreeable jelly of a deep wine color.

The tree is very tender when young, but appears to be quite hardy on reaching maturity. It seems to be quite adaptable to deep sandy soils, and responds well to nourishment and water. It is a uniform-growing tree, not very dense, and does not require pruning. There is a white-fruited type of this species, but there is no record of its having been tried out in southern Florida.

The following analysis, by percentages, is quoted from the Philippines by Wester: Water, 85.13; ash, 0.72; fiber, 2.24; protein, 0.54; fat, 2.12; carbohydrates, 0.02; sugar, 6.81; acidity, 2.42. Calories per kilo of food: 483.

Eugenia dombeyi

The grumichama (*Eugenia dombeyi*), is a small, open-growing tree from Brazil. The glossy leaves are about three inches long and deep green in color; the bark is a brownish gray.

The small fruits are borne in open clusters among the leaves on the mature twigs; they are roundish, up to half an inch in diameter, with the dried flower sepals forming a crown on the flattened flower end. The small, dark-crimson fruits are very pleasant to eat out of hand, and make an agreeable wine-colored jelly if picked before fully ripe; the ripe fruits make good pies and jams.

There is much variation in the quality of the fruits and in the time of ripening in Brazil; so far no superior types appear to have been propagated.

The tree appears to be quite well adapted to southern Florida, provided it is well nourished and given sufficient water. The fruiting specimens in Florida apparently have not had the necessary care for good development; the tree seems to be shallow-rooting and requires good feeding, mulching, and frequent irrigation. On the richer clay soils of Cuba it grows well, but it suffers severely during the long dry season; being evergreen, it does not go thoroughly dormant in the winter season as do the fully deciduous trees. It is quite hardy, however, and can withstand several degrees of frost without material damage.

Eugenia jambos

The rose apple (*Eugenia jambos*), from the East Indies and Malaya, is a very ornamental, spready tree; the dark-green sharp-pointed leaves with their pale-green underside form a dense top, making the tree an ideal one for shade. The whitish flowers with their brush-like clusters of stamens are very showy in contrast to the dark green of the foliage.

The fruit is flattish and round, about one and a half inches in diameter, with a large, round seed, usually loose within the stiff, brittle shell. When ripe the fruit is greenish white; the rose-petal-flavored shell is insipidly sweet and rather dry. To some people the taste of the fruit is very appealing. The ripe shells make a pleasant, mild-flavored sauce which is improved by the addition of a little lime or lemon juice. The full grown fruits while yet green have a good pectin content, but they are not sufficiently acid for jelly-making. They should be used for jelly in combination with an acid fruit low in pectin; the addition of lemon juice in making jelly overpowers the rose apple flavor.

The tree is well adapted to southern Florida and fruits abundantly, although it really has more merit as an ornamental shade tree than as a commercial fruiting one. On becoming established and sending its taproots into the lower moist-soil strata, it withstands drought conditions very well.

The Hawaii Agricultural Experiment Station gives the following analysis, by percentages: Water, 84.15; ash, 0.29; fiber, 0.98; protein, 0.79; fat, 0.18; sugar, 11.73; acidity, 0.03. Calories per kilo of food: 517.

Eugenia luschnathiana

The pitomba (*Eugenia luschnathiana*), from Brazil, is a small tree with narrow, sharp-pointed, dark-green leaves, two and a half to three inches long. In its native country it grows to a height of about thirty feet; in southern Florida it is slow-growing and, although the fruiting plants appear to be in good healthy condition, they have more the appearance of shrubs than of trees.

The fruits, about one inch in diameter, are bright orange-yellow. In size and shape they are almost identical with those of the Surinam cherry, but the seeds are such smaller. The pulp is soft, juicy, aromatic, and mildly acid. The fruit makes an excellent jelly and may be used in other ways, as with the Surinam cherry.

Although slow-growing, the pitomba appears to be quite hardy and well adapted to southern Florida. The quality of the fruit depends largely on the nourishment and water supplied to the plant.

This is a plant well worth growing; it will undoubtedly prove a valuable addition to our fruit list when further disseminated. So far there are only a few fruiting plants in southern Florida.

Eugenia malaccensis

The ohia or Malay apple (*Eugenia malaccensis*), from the East Indies and Malaya, is a quick-growing, upright tree, with thick, dark-green, glossy leaves about six inches long. In Cuba it grows as a medium-sized tree and is quite tender. So far there is no record of this species having reached fruiting age in the United States.

When in fruit, the tree is very ornamental; the slightly pear-shaped fruits, two and a half to three inches long, are dark red in striking contrast to the heavy green foliage. The red skin is extremely thin, and the thick, white shell is similar to that of the rose apple, having a large seed, or two hemispherical seeds, within the deep cavity. The fruit has a rose-petal flavor which unlike the rose apple is not lost in cooking. The slightly immature fruits make a bright, clear jelly of distinctive flavor; the fully ripe fruits make an excellent sauce and syrup.

At present this plant is more suitable for experimental purposes than for general planting in southern Florida. It should prove an interesting

type for the plant-breeder to work with in conjunction with some of the other species of the genus.

The Hawaii Agricultural Experiment Station gives the following analysis, by percentages: Water, 91.39; ash, 0.13; fiber, 0.56; protein, 0.21; fat, 0.03; sugar, 6.88; acidity, 0.06. Calories per kilo of food: 296.

Eugenia uniflora

The Surinam cherry (*Eugenia uniflora*), from Brazil, is the most widely known of the fruiting species of *Eugenia* in southern Florida. Until quite recently it has been grown more as an ornamental than as a fruiting plant. The small, dark-green, glossy leaves make it a very suitable plant for hedges. It also lends itself readily to formal trimming.

The fruits, about one inch in diameter, vary in color from pink to dark red. The seed is large for the size of the fruit; the pulp is juicy, acid, and highly aromatic.

As the plants have been grown from seeds, there is naturally a great variation in quality among them; in flavor the fruits vary from a rank, unpleasant, turpentine taste to a sub-acid, pleasantly aromatic one. There is also a great difference in the bearing qualities, some bushes habitually fruiting so heavily that the branches are weighed down, while others produce very few fruits. So far very little has been done in Florida in the selection and vegetative propagation of selected types.

A black fruiting type bearing high-quality fruits was brought into Florida by the early settlers, and a few of these bushes are to be found in some of the old homestead plantings. Seedling plants from these bushes show much variation; nearly all show the result of cross-pollination with the red type, and they are decidedly inferior to the original black type. Propagation by grafting is necessary in order to perpetuate this most desirable fruit.

The Surinam cherry is perfectly hardy in southern Florida, and appears to be highly tolerant of the alkaline condition of the deep sandy and rocky soils. The plant appreciates good feeding and should have abundant water during the period of fruit development. As a rule the Surinam cherry fruits twice a year, in late spring and in fall, the spring fruiting being the heavier one.

As the bushes grow older and develop thick, woody stems, the fruit produced is inclined to become smaller and of poorer quality. Periodic pruning is advisable in order to eliminate these old woody stems to the benefit of the younger, more vigorous fruiting ones; for this reason it is better to keep the plant in bush form than to trim it into a tree form.

The fruit may be preserved in almost any form, as syrup, compote, jam or jelly. The crushed pulp of the ripe fruit makes a flavorsome sherbet, or it may be made into syrup.

The following analysis, by percentages, is from the Hawaii Agricultural Experiment Station: Water, 90.70; ash, 0.34; fiber, 0.34; protein, 1.01; fat, 0.66; sugar, 6.06; acidity, 1.44. Calories per kilo of food: 341.

Psidium

Psidium, the guava, is perhaps the most widespread and best-known fruit of the American tropics and subtropics. The jelly and paste made from the fruit of the common guava are widely known favorites everywhere.

There are about one hundred and fifty species of *Psidium* listed, although there is apparently much duplication of names and a lack of clarity in classification; with the common guava, especially, there are numerous types known by local names. The guava was a favorite fruit with the early peoples of the American tropics, and is now established throughout the warmer parts of the world. The guavas are not very particular as to soil conditions, and are able to withstand considerable neglect and abuse.

The guavas are all quite drought-resistant, but require plenty of water during the fruiting period for the development of good fruits. Most of the dropping of small, undeveloped fruits, and also failure to set fruits after blooming, are due chiefly to insufficiency of water at this period.

Psidium littorale

The strawberry guava (*Psidium littorale, P. cattleianum*), from Brazil, is the finest flavored of the guavas. There are several types, the red one with a pronounced strawberry flavor being the general favorite. It is a very decorative shrub with its brown bark and thick, glossy, dark-green leaves; the dark-red fruits contrast sharply with the foliage.

There is much variation among the seedling plants, some of them being poor bearers while others are quite prolific. The size of the fruit does not vary much among the seedling plants, the general quality of the fruit seeming to depend largely on the vigor and well-being of the plant. The bush is fairly fast-growing and in good soil will reach a height of twelve to fifteen feet. It is hardy, and will withstand several degrees of frost without injury.

In general the strawberry guava is well adapted to southern Florida. On dry, deep sandy soils it requires irrigation during the fruiting season, and on rocky soils it should be kept mulched on account of its shallow rooting.

The bush should not be permitted to grow tall; owing to the open form of the top it is then difficult to pick the fruits, and also they are not so large or flavorsome on an old, woody plant. Pruning is advisable in order to keep the bush low for facility in picking, and to maintain a strong new growth capable of producing large fruits.

The fruits average an inch in diameter, with a thick, soft shell enclosing a sweet pulp, containing many small, hard seeds. The ripe fruits are very good to eat out of hand or they may be served with sugar and cream. The pulp separated from the seeds makes good custards and ices; mixed with milk and sugar and a pinch of salt, it makes a very good drink somewhat similar to that made from the annonas. The fully grown fruit, when just beginning to color, makes a bright-colored jelly of superior quality.

A large-leaved form of the red Cattley guava with slightly larger fruits has been tried out in Florida. It appears to be a poor bearer and is not as valuable as the small-fruited type.

Psidium littorale lucidum is the yellow fruiting form of the strawberry guava. It is less ornamental and the fruit, which is slightly larger, is not so flavorsome, tasting sweeter and being somewhat flat. The shell is harder and drier, and jellies made from the fruit are insipidly sweet. There are two bush forms, an upright-growing and a sprawly one; there is no appreciable difference between the fruit of the two forms.

The following analysis, by percentages, comes from the Hawaii Agricultural Experiment Station report for 1914:

Red Cattley: Water, 81.73; ash, 0.74; protein, 1.03; fiber, 6.14; fat, 0.55; sugar, 4.46; acidity, 1.17. *Yellow Cattley:* 79.92; ash, 0.63; fiber, 3.87; fat, 0.42; sugar, 10.01; acidity, 0.69. Calories per kilo of food: 268.

Psidium guineense

The Brazil guava (*Psidium guineense*), is a small fruiting species. It is probably a subspecies of *P. guajava,* which includes a large number of types formerly classified as separate species. It is a low, open, spready bush with light-green leaves from three to four inches long; the branches and twigs are quite slender.

The small fruits, from half to three-quarters of an inch in diameter, are round and pale yellow when ripe, and shed readily on maturing.

The thin, dryish shell is lacking in flavor, but the soft, sweet, mildly acid pulp has a pleasant taste. The fruits are borne in clusters of three or four on the young twigs. In shape, flavor, and color they resemble those of *P. molle* more closely than any other of the guavas, but they are much smaller. They make an agreeable-tasting jelly with a rather distinctive flavor.

The bush is fairly hardy and is quite prolific. The fruits are of fine quality and the plant is well worth including in a grouping of guavas for home use. A species recently introduced under the name of *Psidium cujavillus* is to all appearances the same as *P. guineense*.

Psidium friedrichsthalianum

The Costa Rica guava (*Psidium friedrichsthalianum*), from Central America, is a slender, medium-sized tree with thin, reddish twigs; the bark is reddish brown with grayish patches. The leaves are slender, about three inches in length, glossy and dark green, with the underside grayish green.

This tree is not a very heavy bearer, but is a worthwhile one on account of the acid fruits, which are quite different from those of the other guavas. The yellow fruits are round, from two to two and a half inches in diameter, with a thin, dryish shell enclosing a soft, acid pulp with very few seeds. The fruits somewhat resemble those of the common guava in appearance but do not have their aroma or flavor. The shell is somewhat reminiscent of the pear in flavor and is excellent for pie-making. The soft, whitish pulp makes a good "ade," being sprightly acid and of an agreeable flavor. The fruits, even when fully ripe, make a high-quality jelly.

The plant is quite hardy and adaptable to southern Florida. It may not be a sufficiently heavy bearer for commercial plantings but is worthy of planting for home use. It will grow under any conditions suitable for the common guava; it is open-growing, and does not appear to require any special pruning or cultural treatment.

Psidium guajava

The common guava (*Psidium guajava*), originated in Central America and has spread throughout the American tropics and subtropics, the West Indies, and all the warmer parts of the world.

Having been grown from seed through so many plant generations under diverse soil and climatic conditions, the species naturally has an extreme variation in type and in quality of fruits. The common guava

does not come true from seed, and seedlings from any bush will show some variation from type. Budding, grafting, and root-suckers are the accepted methods of propagating the better forms.

There are two main types of fruits; the round and the pear-shaped ones. In color of flesh, the variations run from creamy white through yellow to dark pink, and in flavor from mild, sweet-flavored fruits, suitable for desserts, to highly acid ones suitable for jelly. The fruits vary from small, thin-shelled ones to the large, thick-shelled ones suitable for making the famed "cascos" or preserved shells, a favorite dessert throughout the West Indies.

The average guava bush, if left undisturbed, will in a few years form a small tree; as such it has a certain rugged beauty. The fruits, however, usually become smaller and stronger flavored as the tree develops in size. Such fruits are satisfactory for jelly-making but if large, mild-flavored fruits are desired for dessert or for baking, the bush should be occasionally pruned to stimulate the growth of young shoots. The twigs of the two- or three-year old shoots give the best fruits. This pruning also facilitates picking the fruits at the desired stage of maturity. The fruits of any guava bush can be almost doubled in size by pruning and by supplying water regularly during the fruit-bearing season. In light sandy soils the addition of dairy manure or compost is recommended.

The fruit varies in size from one inch in diameter to over three inches; the larger, mild-flavored ones are used for preserving or for baking, or served sliced with sugar and cream as dessert, the smaller, more acid ones being better for jelly. There is a great difference in the jelling qualities of the different types; some have a high pectin content but are low in acid, thus requiring the addition of acid during cooking in order to release the pectin. The thick shells of the larger fruits make good pie stock, deep-dish pie or cobbler being a general favorite. The soft pulp of the milder-flavored fruits make a distinctive "ade," a little lime or sour orange juice giving an added piquancy.

The guava is quite hardy in southern Florida. The young plants should be protected during a cold spell, but if killed back by frost they will sucker out again. The plant is not particular as to soils, and readily becomes established on any soil that is not water-logged.

In spite of the numerous types and forms of the guava existing in southern Florida, there are at present no horticultural named varieties offered for sale by growers. No systematic work has been done on the selection and propagation of superior strains; there is a great necessity for such work if the guava is to be raised to the position it so richly deserves in both commercial and home plantings.

Cardenas and Moreno give the following analysis, by percentages, of the guava from Cuba:

Round Guava: Water, 78.00; protein, 0.90; fat, 0.40; sugar, 7.70; carbohydrate, 2.70; fiber, 8.50; acidity, 1.00; ash, 0.80. Coefficient of digestibility: Protein, 85.00; fat, 91.00; carbohydrate, 91.00.

Pear-shaped Guava: Water, 75.90; protein, 1.00; fat, 0.45; sugar, 9.95; carbohydrate, 3.00; fiber, 7.80; acidity, 0.90; ash, 1.00. Coefficient of digestibility: Protein, 96.00; fat, 91.00; carbohydrate, 90.00.

Psidium molle

The guisaro (*Psidium molle*), from Central America, is a species of guava worthy of more attention than it has so far received. The bush, or small tree, is not so strong-growing as the common guava. The stiff, rough leaves from four to six inches long are oval, sometimes broader at the tip than at the base. The bark is grayish and the general color of the bush is a grayish green; the slender young twigs and the leaves have a reddish tinge, turning green as they develop.

The fruit is round, from one to one and a half inches in diameter, borne on the mature twigs sometimes in clusters of two or three. The shell is soft and thick, and pale yellow when ripe, the inner seedy pulp being whitish. The entire fruit is mildly acid, with a slight strawberry flavor, and like the Costa Rican guava it does not have the strong aroma of the common guava. The ripe fruit is suitable for baking, and jelly made from the fully-grown immature fruits is decidedly superior in flavor to that produced from the other guavas.

The young plants are tender but become hardy on reaching maturity. The species is quite adaptable to southern Florida but requires more care than the common guava. On dry rocky and deep sandy soils it fails to set fruit unless well irrigated at the time of flowering. The bush is open-growing and does not require any special pruning treatment for fruiting beyond an occasional thinning out of the suckers inside the top. It responds well to nourishment and well repays good treatment.

Myrciaria

Myrciaria is a genus native of Brazil closely related to *Eugenia,* the several species having been at times classified as representatives of the latter genus. Several species are grown in Brazil for their fruits, but so far *Myrciaria cauliflora* is the only one well known outside its native region.

The jaboticabo (*Myrciaria cauliflora*), is one of the spectacular fruit-

ing trees of the American tropics, the small, round, grape-like fruits being borne in clusters on the trunk and large limbs. Under good conditions the tree reaches a height of thirty-five to forty feet; in the subtropics it is slow-growing. A few fruiting trees in Cuba over twelve years old are not yet ten feet tall. The narrow leaves, about two inches long, are light green and form an airy half-shade throughout the tree top.

The fruits average an inch in diameter, and are dark purple, almost black, when ripe. The thin, tough skin covers a soft, white, juicy, jelly-like pulp with a few small seeds. The pulp has a pleasant grape flavor and is much used in Brazil for making wine. A distinctive-flavored, dark wine-colored jelly is made from these fruits.

The tree appears to be fairly hardy in southern Florida, although it is a very slow-growing one. It is tolerant of alkaline soils but requires richer soil conditions for good growth. Application of organic manure and mulching is recommended.

Rhodomyrtus

The downy myrtle or hill gooseberry (*Rhodomyrtus tomentosa*), is a dwarf, spready shrub from tropical Asia. It is very little known in southern Florida, but the few specimens existing there are prolific bearers. This plant is better known further upstate, especially on the west coast; it is indeed surprising that it has not become more widespread.

The plant is very ornamental, with light-green leaves fuzzy on the underside and about two inches long. In the spring and early summer it is almost covered with small, rose-pink flowers turning to light purple as they age.

The fruits are round, about a quarter of an inch in diameter, and dark purple when ripe. In shape the fruit is like a miniature guava; it makes excellent jam and pies.

The bush is quite hardy in southern Florida and will withstand several degrees of frost. It appears to be adaptable to deep sandy and rocky soils, but requires more humus than is naturally provided in such places. In a dry spring the fruits often fail to set, an indication of the necessity for irrigation at this time.

OXALIDACEAE

The family Oxalidaceae contains seven genera, of which two, *Oxalis* and *Biophytum* are ornamental plants. Of present interest is the genus *Averrhoa* with its two species, *A. bilimbi* and *A. carambola.*

The bilimbi or cucumber tree (*Averrhoa bilimbi*), from tropical Asia, is a very interesting tree, bearing its pickle-like fruits in clusters on the trunk and at the base of the branches. It grows to be about twenty feet high, with stiff, upright branches and an open top; the pinnate leaves with broad, sharp-pointed, velvety leaflets are crowded at the ends of the thick, brittle branchlets.

The thin-skinned green fruits, about an inch in diameter and from two to three inches long, turn light yellow when ripe. The flesh is firm and juicy, rapidly becoming soft on maturing. The fruit is extremely acid and makes a very tart jelly; the fully ripe fruits are also used in making drinks. The mature fruits, before turning soft, can be preserved in syrup or pickled.

The tree is very tender for southern Florida when young, but becomes hardier on reaching maturity and may be grown in a protected location. It requires a rich, moist soil as well as protection from winds.

The following analysis, by percentages, is quoted by Wester from the Philippines: Water, 94.70; ash, 0.40; protein, 0.61; sugar, 2.21; acidity, 1.20.

The carambola (*Averrhoa carambola*), long a favorite with the Chinese, is another interesting fruit from tropical Asia. This upright-growing tree has an open style of branching; the fruits are borne on the older twigs and young branches throughout the tree-top. The tree reaches a height of twenty-five to thirty feet in good soils and is a fairly rapid grower. The leaves are pinnate, with broad, sharp, pointed, tender leaflets.

The shape of the fruit is unique; varying from two to four inches long, it is so deeply angled as to be star-shaped in cross-section. The skin is very thin, covering a firm, juicy flesh containing a few small seeds. To some people this fruit has a strong appeal, but others dislike it. The flavor is quince-like, becoming even more pronounced on cooking. The fully-grown immature fruits make a firm, cloudy yellow jelly with a pronounced quince flavor. The ripe fruits may be made into jam or pressed for drinks. Chilled and sliced thin in cross-sections they make an interesting addition to salads.

The tree is much hardier than the bilimbi and can stand more exposure. For good, well-developed fruits it requires a rich soil and abundant water. A sweet form has recently been introduced but so far is not very common.

Wester quotes the following analysis, by percentages: *Sour form:* Water, 0.60; ash, 0.51; protein, 0.84; sugar, 0.24. *Sweet form:* Water, 1.78; ash, 0.42; protein, 0.72; sugar, 0.78.

PASSIFLORACEAE

The family Passifloraceae contains eighteen genera, mostly of the American tropics and subtropics. The genera *Passiflora* and *Tacsonia*, so interrelated as often to be grouped together, mainly from South America, have between them over two hundred species, chiefly ornamental vines. A few species of *Passiflora* have edible fruits of commercial value, the more important ones being briefly mentioned below.

The passifloras have never been very successful in southern Florida; they are highly susceptible to the nematode infection so prevalent in sandy soils. There must be some species with a sufficiently high degree of nematode resistance to prove suitable as a root-stock for the finer and more tender species; but there is no record of investigations along this line. Until some practical results are arrived at in dealing with the nematode problem, special care must be taken with the soil in which these plants are grown.

Passiflora quadrangularis

The granadilla (*Passiflora quadrangularis*), of tropical America, has the largest fruits of all the passifloras. It is a strong-growing vine with rough, square shoots and large, soft, light-green leaves about eight inches long.

The fruit, six to eight inches long and four to five inches thick, is pale green, becoming lighter in color on maturing. The thick, firm, fleshy shell, one to two inches thick, encloses a cavity partly filled with seeds embedded in a juicy, mildly-acid pulp. The pulp may be eaten from the shell or strained for making fruit drinks. The fully grown green fruits are used as a vegetable, while the ripe fruits are cooked with sugar as a sauce. When the shell alone is used for sauce, it requires the addition of a little spice.

The vine is really an annual, and should be rapidly grown in specially prepared holes of rich compost, in a sunny place well protected from strong winds. For the development of succulent fruits, abundant water with proper drainage is necessary.

Passiflora edulis

The passion fruit (*Passiflora edulis*), from Brazil, is a quick-growing vine of a more slender habit than the granadilla. It is a strong grower, and requires a large trellis or fence for proper development. The vine makes a woody growth and will readily stand pruning back each year

for better control and fruiting; unlike the granadilla, the leaves of the passion fruit vine are deeply three-lobed.

The fruits are round or slightly oval, two and a half to three inches long, and deep purple when ripe. The shell is thin and tough, containing a gelatinous mass of seedy pulp, more acid than that of the granadilla and more sprightly in flavor. The pulp is ideal for making cold drinks; a pinch of bicarbonate of soda reduces acidity and gives an effervescent action as with grapefruit or lime "ades." The pulp may be used for sherbets or eaten from the shell with the addition of sugar. On storage after maturity, the outer shell of the fruit dries and wrinkles; the pulp also loses some of its moisture but softens up readily in water. The vine is quite hardy in southern Florida but is somewhat susceptible to nematode infection.

Wester gives the following analysis by percentages: Water, 86.51; ash, 0.67; protein, 0.81; fat, 0.70; sugar, 8.08; acid, 3.16. Calories per kilo of food: 418.

Passiflora lingularis

The sweet granadilla (*Passiflora lingularis*), is somewhat similar to *P. edulis;* the vine makes a similar growth but the leaves instead of being lobed, are sometimes almost heart-shaped.

The fruit is slightly longer than that of the passion fruit and is buff yellow when ripe. Like that of *Passiflora edulis,* the fruit shrivels after maturity but readily softens in water. The pulp may be used in the same way as that of *Passiflora edulis,* in comparison with which it is sweeter and of a finer flavor.

The vine is quite hardy in southern Florida and a heavy bearer. It does not suffer so readily from nematode infection as do the other two species listed.

PROTEACEAE

The family Proteaceae consists of about fifty genera, principally natives of Australia, and South Africa, chiefly ornamental shrubs and timber trees, the best-known being *Grevillea* and *Banksia. Macadamia* is of interest in the present case as bearing edible seeds.

Macadamia ternifolia

The Queensland nut (*Macadamia ternifolia*), from Australia, is a medium-sized evergreen tree with a dense head of narrow, dark-green, holly-like leaves. It is quite hardy in southern Florida and can with-

stand several degrees of frost. It is admirably adapted to sandy soils and can stand drought very well. There is much variation in its bearing qualities and in the size of the nuts and thickness of the shell. Vegetative propagation will be necessary to reproduce the better strains. The tree is a shapely grower and does not seem to require pruning. They are, in general, quite prolific, the fruit being borne on the mature twigs.

The round nuts resemble marbles and are about one inch in diameter; the hard shell has a rich brown color and usually requires a hammer to crack it; the kernel is rich and of good flavor. It is one of the very best nuts when roasted and salted, and is now attracting much attention as a possible commercial crop in Hawaii.

Analysis from the Hawaii Agricultural Experiment Station shows the following percentages: Water, 7.01; ash, 1.62; fiber, 1.92; sugar, 2.68; acidity, 0.10.

PUNICACEAE

Punica is the only genus in the family Punicaceae. They are small trees or shrubs; several forms, especially the double-flowered ones, being grown only as ornamental plants. The true pomegranate forms a large bush with many stems and thin, wiry branchlets; the leaves are narrow and vary in length from two to three inches.

The pomegranate is really a subtemperate plant, and although found growing throughout the subtropics and even in the tropics, it cannot be considered to be a successful fruiting plant for southern Florida. The plant grows fairly well in the sandy and rocky soils, but the fruits do not develop normally; possibly through improper pollinization of the flowers, or possibly because the species is a native of subarid regions, the fruits in Florida are usually poorly developed, dry, and bitter. Fertilizing and irrigation does not appear to improve the quality of the fruits sufficiently to warrant the effort.

RHAMNACEAE

This family contains several genera of trees, the jujube, which bears edible fruits, being of interest to us.

The Chinese jujube, with several types and horticultural varieties, is *Zizyphus jujuba* (*Z. vulgaris, Z. sativa*), and the Indian jujube is *Zizyphus mauritiana*. The Indian jujube is readily distinguished from the Chinese one by having a whitish or brownish fuzz on the underside of the leaves, the leaves of the Chinese being pale green and smooth on the underside.

The Chinese jujube is a native of Asia, and has been under cultiva-

tion in China for several thousand years. It is now one of the outstanding fruits of China, and many superior named varieties are commonly recognized, the principal ones being the lang, the mu shing hong, and the yu. They are quite hardy in northern Florida, being well adapted to the light sandy soils and can withstand dry winds and drought conditions. They are fairly cold-resistant and can withstand several degrees of frost. In China the fruits, known as Chinese dates, are usually dried or candied.

The Indian jujube is more tropical than the Chinese jujube and is better adapted to the soils and climatic conditions of southern Florida. Very little work has been done with it there, and further investigation is needed with a view to the propagation of varieties suitable to this region.

The Indian jujube reaches a height of twenty-five to thirty feet; it is upright in growth when young, becoming spready with drooping branchlets on attaining full maturity. The oval leaves, two to three inches long, are a dark, glossy green on the upper side and much lighter and hairy on the underside. The long, slender branchlets and twigs are armed with short, very sharp spines, making fruit-picking somewhat difficult. The tree is very graceful and has a high ornamental value.

The fruit of the Indian jujube varies from round to oval, three-quarters to one inch in length; the seed, large for the size of the fruit, is enclosed in a firm, whitish flesh which varies in flavor from sweet to mildly acid. The fruits of the better types are eaten fresh. The ripe fruits make an agreeable sauce, and jelly can be made from the green ones.

Popenoe quotes the following analysis for dried fruit, by percentages, in his "Manual of Tropical and Sub-Tropical Fruits": Water, 69.10; ash, 0.73; fiber, 1.28; protein, 1.44; fat, 0.21; carbohydrates, 2.47; sugar, 21.66. Calories per kilo of food: 1041.

ROSACEAE

The Rosaceae is an extensive family of some thirteen tribes, containing among them over ninety genera and a vast number of species distributed throughout the world. The family is of great commercial value throughout the temperate zone, as it includes the apple, pear, peach, raspberry, strawberry, quince, cherry, prune, plum, and various other well-known commercial plants.

There are very few tropical fruits of commercial value belonging to the Rosaceae. While the loquat is grown in tropical countries, it is successful there only at higher altitudes where the conditions are really subtropical. The same is true of several species of the blackberry, the

cherry, and the hawthorn. The coco plum (*Chrysobalanus icaco*), is the only truly tropical representative of this family. It grows wild in southern Florida, while the introduced loquat is more at home in the northern part of the state. They both produce fruits of economic value and the plants are adaptable to the soil and climatic conditions of the region.

Chrysobalanus

The coco plum or icaco (*Chrysobalanus icaco*), is found in a wild state in the coastal regions of North and South America in the tropical and subtropical zones. In southern Florida it grows in a healthy condition on the deep sandy ridges and throughout the flatwoods wherever there is good drainage. On the dry lands it remains a small bush, but reaches a height of seven or eight feet on the richer moist lands of the flatwoods. Its roundish, dark-green, glossy leaves, about two inches long, form a dense mass on a compact bush, making it a striking ornamental plant.

There are two types of the coco plum both with a single large seed. The fruits of the commoner purple one are oval, about an inch long, with a dark-purple skin and soft, white, spongy flesh. Those of the white or cream-colored type are nearly round, about one and a half inches long, with a creamy-white skin which takes on a pinkish tinge on ripening; the skin is thin, and the flesh is soft and spongy.

The fruits of both types make good jam; those of the white type make a pleasant-flavored jelly even when ripe, while those of the purple type must be picked just before ripening for jelly making.

Eriobotrya japonica

The loquat (*Eriobotrya japonica*), is a small evergreen tree growing to a height of fifteen to twenty feet. The leaves are stiff and rough, from eight to ten inches long, dark green on the upper surface, and slightly woolly on the under surface and on the young shoots. The leaves are more numerous near the ends of the branches, the fruits being borne in loose clusters at the tips of the shoots.

The fruits are oval, slightly pear-shaped, one and a half to two inches long, and of a pleasant, mildly acid flavor. They vary from pale yellow to light orange. The tough, slightly woolly skin is relatively thick for the size of the fruit; the seeds may vary from one or two up to ten, but usually few in number. They occupy the center cavity, being surrounded by a firm, fleshy pulp. The fruits may be used very much like apples in baking or preserving; the partly ripe fruits make a firm, delicately flavored jelly.

The conditions of southern Florida are not ideal for the loquat. It grows in a fairly healthy manner, however, and fruits well, although the fruit does not develop its finest flavor under our conditions. It is nevertheless a plant well worth growing for home use.

On dry, sandy soils, applications of cow manure or compost are recommended, and a plentiful supply of water is necessary during the fruiting period. If the plant be allowed to suffer for lack of water, the thick bark becomes tough and the subsequent growth is stunted through bark-binding. On thin, rocky soils, mulching is necessary for protection of the surface roots from excessive drought.

Very little has been done in Florida to improve the loquat. Several improved varieties are recognized in California, where plantings are being made on a commercial scale.

Florida Experimental Station Bulletin No. 237 quotes the following analysis, by percentages: Water, 77.90; protein, 0.20; fiber, 0.60; ash, 1.10; sugar, 11.34.

RUTACEAE

The family Rutaceae has over one hundred genera, most of them in the Citrus tribe being species producing edible fruits of more or less commercial value. Some of the genera are very little known in general horticulture; certain of the lesser-known ones are being tried out in test plantings, and may prove suitable as root-stocks for the higher developed citrus varieties or for hybridization.

A characteristic of the family is the presence of oil glands in most of the fruits, and also in leaves and flowers. The most important genus is *Citrus,* which contains numerous species of high economic value such as the orange, grapefruit, lime and lemon, etc., all originally natives of the Old World tropics.

Citrus

Several species and a great many horticultural forms are now in cultivation throughout the tropics and subtropics, and numerous horticultural varieties are recognized in commerce. A number of hybrids are fairly common in citrus-growing sections, and more are undergoing tests in experimental plantings.

Southern Florida is not very suitable for the culture of citrus on a commercial scale. Given proper care, a few trees for home use will prove to be quite satisfactory.

It is impossible within the limits of this book to give an adequate dis-

cussion of citrus diseases. A complete treatise on the subject has been issued by the Florida Agricultural Experiment Station (Bulletin 183).

The ranjpur lime and the calamondin are noticeably successful on the deep, dry, sandy soils of southern Florida. For some of the lighter-growing species, such as the tangerine, the kumquat, and the limequat, the calamondin may prove to be a better root-stock than those in present use in this section.

Citrus aurantifolia

The lime (*Citrus aurantifolia*), is a small, irregular-growing tree, with short, sharp spines on the branches. The leaves are light green, oval, and two or three inches long. The fruit varies from round to oval and from one and a half to over two inches in diameter, and is greenish yellow when ripe; it has a thin peel and a juicy, acid pulp with small seeds.

The Mexican or key lime is very sensitive to cold, and should be planted in locations sheltered from the north and northwest winds of the winter months. This lime is grown commercially on the Florida Keys, the rocky soil and climatic conditions of that area being remarkably suited to it. In the deep sandy soils the tree does not fruit so abundantly and the fruits are generally of a poorer quality, having a thicker peel and less juice. In these soils the tree is subject to die back and to failure to set fruit properly, owing to extreme fluctuations in the amount of moisture available.

The Tahiti or Persian lime is more suitable to deep sandy soils than is the key lime. The fruit is larger and resembles a small lemon in shape; it is smooth-skinned and juicy. The tree is a fairly heavy bearer and is desirable for home planting where the fruit may be picked fresh for immediate use. The fruit has poor keeping qualities and is thus not satisfactory for shipping; it must be picked green for this purpose and is consequently not at its best as found on the market stands. For home use it is to be highly recommended; the fruit is of good quality where it is allowed to mature on the tree.

The sweet limes of the West Indies are considered to be hybrids; they may, however, be mutations. They are insipid and of very little appeal as juice fruits.

The Rangpur lime is much hardier and more tolerant of adverse conditions than either the limes mentioned above or the lemon. The fruit resembles that of the tangerine in size, shape, and color. It peels readily like the tangerine, but is highly acid. The fruit ripens early in the winter season, usually in November, and remains on the trees well into

spring, but is apt to dry out after ripening unless the tree is irrigated during the dry season.

The tree is quite hardy in southern Florida and is not too particular as to soils. It grows and fruits equally well on the rocky and deep sandy soils, preferring the drier soils to the wet ones. The tree is a spreading topheavy grower and requires periodic pruning of the side shoots. The fruit is susceptible to attacks by the rust mite, which spoils its appearance, affects its development, and causes it to dry out rapidly on ripening.

Citrus aurantium

The Seville or sour orange (*Citrus aurantium*) is not as popular in southern Florida as it is throughout the West Indies. In Cuba especially it is used freely for juice. As a fruit for "ades" it is more flavorsome than the lime or lemon, and as an acid for fish it is greatly preferred. For the average home-yard planting, especially on deep sandy soils or poorer drained flatwood soils, the sour orange may prove to be more prolific than the lime or lemon; its fruits have the same uses as an acid for "ades" or flavoring; it is also an ideal fruit for making marmalades and jellies.

The sour orange was presumably brought to Florida by the early Spaniards. The tree is of medium size, usually of a more upright growth, and with a more compact head than the sweet orange. The branches have long, blunt spines and the leaves are lighter green than those of the sweet orange. The fruits average about three inches in diameter and vary from round to slightly oblong; it is thick-skinned, pulpy, and medium as to juice content.

The tree is quite hardy and can withstand adverse conditions. It is quite resistant to cold winds and is able to withstand several degrees of frost without damage. It has a wide range of adaptability to soil conditions in southern Florida, growing well on the deep sandy soils and being able to withstand occasional flooding on the low flatwood lands.

The tree-top is prone to overcrowding; a light thinning out of weak or overcrowding shoots from the inside is necessary every year or so in order to keep the top in good fruiting condition. While the tree is very resistant to gummy foot rot on wet soils, the leaves are quite susceptible to leaf scab.

Citrus vulgaris

The bitter-sweet orange (*Citrus vulgaris*), is supposedly a hybrid between the sour orange and the sweet orange. It is a good juice fruit when ripe but has a tendency to become dry and flat-flavored if allowed

to remain on the tree too long. The fruit is similar to that of the sour orange in size and shape, but the pulp is darker and not so acid.

The tree is quite prolific, but cannot be considered so valuable for home use as the sour orange. It does not have the same wide range of adaptability to soil conditions, nor are the fruits so useful, although they make very good marmalade.

Citrus grandis

The grapefruit or pomelo (*Citrus grandis, C. maxima*), is a larger tree than the sweet orange, usually with a spready, rounded top. In a few varieties the branches have blunt spines, but in most they are spineless. The leaves are larger than those of the sweet orange and are readily distinguished from the latter by the pronounced wings on the leaf stalk.

The fruits vary in size and shape but are generally round, occasionally somewhat flattened five or six inches in diameter, and pale yellow when ripe. The thick, pithy peel makes the fruit a good shipper, since it is possible to keep it a long time after picking in fairly good condition.

The grapefruit (*Citrus paradisi* or *C. grandis* var. *paradisi*) is now planted commercially throughout the subtropics, but the larger plantings in the United States are in California, Arizona, Texas and central Florida. Southern Florida is not an ideal grapefruit section, profitable orchard plantings being limited to a few areas of heavier soil. For home plantings of a few trees, the grapefruit may be successfully grown on any of the southern Florida soils, provided the roots are not waterlogged. The rough lemon, the sour orange, and the grapefruit rootstocks are suitable for the grapefruit, the latter two being the more satisfactory.

The fruit is chiefly used as a breakfast dish; it also makes a good drink. If the acid flavor is too pronounced a pinch of bicarbonate of soda makes an agreeable effervescent drink.

In hardiness the grapefruit tree is similar to the sweet orange. The young trees are tender but soon become hardy on acquiring woody growth; a tree two or three years old will safely withstand a slight frost.

In early nursery practice, the grapefruit was grown from seed. This gave rise to innumerable local varieties. As with the sweet orange, there are so many variations that the propagation of the better varieties by budding is now a necessity. Early mid-season and late maturing varieties are now procurable on the desired root-stock for local soil conditions, and may be confidently bought as true to name from reliable nurserymen.

The four most suitable varieties for home plantings are the Duncan, a general favorite and a good all-round fruit, early maturing, juicy, and of a fine flavor. The Foster is a good variety, later than the Duncan. It has a light-pink flesh and is an attractive fruit for the table. The Marsh seedless is a favorite variety on account of its lateness; it holds its fruit well after maturity if not allowed to dry out for lack of water. The Thompson is a pink flesh sport grown from Marsh seedless; it is late-maturing, of medium size and juicy.

Citrus limonia

The lemon (*Citrus limonia*), is a small tree of open, irregular growth, the branches usually having short, stiff thorns. The leaves are pale green, oval, and taper to a sharp point, the edges being slightly toothed.

The fruit is oval, averaging three to four inches long, with a blunt, projecting point and is usually lemon-yellow when ripe. The thick peel has an uneven surface and is prominently dotted with oil sacs. The juicy pulp is very acid and contains few seeds.

On the whole the climate of southern Florida is too humid for commercial lemon-growing. For home use the lemon may be grown with fair success; of the several horticultural varieties offered, the Villa Franca appears to be the most suitable for this region.

The rough lemon is quite common in southern Florida and is often found growing naturally in woody places. It is a large, rough, thick-skinned fruit, having very little juice, and is really not a worth while tree for home planting.

The Perrine lemon is not a true lemon, but a hybrid between the Genoa lemon and the Key lime; it is now being developed in commercial plantings. It is quite hardy and is more suitable for conditions further upstate; it is quite satisfactory, however, as a home-yard tree for southern Florida, where the fruit may be left on the tree to ripen thoroughly before picking.

The Mayer lemon, a hardy type introduced from China, has proved to be well adapted to southern Florida. It is a large, round fruit, like the orange in size, shape, and color, and the tree is very prolific. The market objection at present to this fruit is its close resemblance to the orange. For home use it is an excellent fruit and should be included in every home planting. The tree appears to be better suited to conditions in this region than are the other varieties of lemons offered for sale by nurserymen. It makes a good head growth and carries its fruit to maturity more readily than do any of the other lemons.

Citrus medica

The citron (*Citrus medica*), is a small, straggly growing tree or large shrub; the shoots are armed with short, thick thorns. The oblong leaves, four to six inches long, are light green, with uneven edges and a blunt tip.

The fruits are unevenly ovoid, six to eight inches long, with a thick, lumpy skin, yellow when ripe. The pulp is dry and coarse and of very little value. The citron is preferably grown for its fragrant peel, famous in the candied form.

The citron is quite hardy in southern Florida but has not been planted extensively. It is adaptable to the light sandy soils but requires organic manure for best results. Several old specimens are to be found in early homestead plantings but they have not been prolific bearers. There are several seedling strains in this district, but the only variety of merit is the Corsica.

The citron has been grown on a commercial scale in Corsica for many years and shipments have recently been made from Palestine. The etrog, a small, aromatic type, is used in Jewish ceremonies; it is grown principally on the island of Corfu.

As a home-yard fruit, the citron does not have the economic value of most other fruits; its principal use is in the form of candied peel, and this article is not in sufficient demand to make the care of a tree worth while for the average household. The tree is a very straggly grower and requires annual pruning to keep it in shape.

Citrus microphylla

The calamondin (*Citrus microphylla, C. mitis*), from the Philippines, is a slender-branched tree of upright growth, fifteen to twenty feet in height; the leaves, two to three inches in length, are oval, and a lighter green than are those of the orange.

The fruit is round, one to one and a half inches in diameter, and with a thin, orange-yellow peel; the pulpy sections which separate readily, are juicy and sub-acid. Although small this is a good juice fruit. It makes excellent marmalade of a distinctive flavor; it is very high in pectin and has practically no citric acid flavor. The entire fruit may be used, after removing the seeds.

For home planting, the calamondin is a valuable tree and deserves to be planted more than it has been so far in southern Florida; besides being an excellent marmalade fruit, it is ideal for "ades" and is a valuable substitute for lime or lemon as an acid for meat or fish. The tree is hardy and will withstand light frosts; it is adaptable to the deep

sandy soils, being also very drought-resistant. It requires little pruning and no special treatment.

Wester gives the following analysis, by percentages, from the Philippines: (1) *Whole Fruit:* Water, 86.12; ash, 0.54; protein, 0.86; fat, 2.41; sugar, 3.27; acidity, 2.81. (2) *Pulp:* Water, 85.76; ash, 0.68; protein, 1.40; sugar, 0.41; acidity, 4.79. (3) *Juice:* Water, 89.66; ash, 0.62; protein, 0.01; sugar, 0.53; acidity, 5.52.

Citrus nobilis

The King orange (*Citrus nobilis*), is a slender, upright-growing tree with narrow dark-green leaves, more or less pointed.

The rough-skinned fruit is about three inches or more in diameter; it has a thick, dry, spongy peel easily separated from the pulp. The pithy center is usually hollow and the pulpy sections readily separate on peeling. The fruit is ideal for eating out of hand or for use in fruit salads. The flavor is very agreeable but the juice is not satisfactory for "ades." The fruits do not keep well on the tree after maturing but dry out quickly, and should therefore be used as soon as they reach maturity.

Citrus nobilis, var. *deliciosa,* the Mandarin orange, is a small, spreading tree with thin branches and twig-like shoots. The leaves are narrow and dark glossy green. A well-grown tree is highly ornamental, the numerous small, bright fruits standing out in contrast to the fine, dark foliage.

The fruit, two and a half to three inches in diameter, is round or slightly flattened with a thin loose peel. The color of the fruit varies with different varieties and stages of maturity from orange-yellow to deep orange. The pulpy sections separate easily and make this a good fruit for eating out of hand.

This fruit is commonly known as the tangerine, but the latter is simply a horticultural variety of the mandarin orange group. The name "tangerine" properly refers to the variety Dancy tangerine; other horticultural varieties being the mandarin and the Oneco. There are several more varieties, of less importance. The leaves of the variety mandarin are narrow and the fruit is light orange-yellow when ripe. The leaves of the Dancy are broader and larger and the fruit, averaging a little larger, is orange-red when ripe. The mandarin ripens early, the Dancy in mid-season. The Oneco is similar in color to the mandarin, but is larger and ripens in mid-season.

The Satsuma, a subspecies of *Citrus nobilis,* is a hardy form from Japan. It is grown successfully in commercial orchards in northern

Florida and the Gulf States, and requires cool weather, even a slight touch of frost, for proper fruit ripening. It cannot be recommended as a satisfactory fruit for southern Florida, as it does not mature properly there.

Citrus sinensis

The sweet orange (*Citrus sinensis*), is a medium-sized tree, of upright or spready growth; in general the seedling trees have a more upright growth than do the budded ones.

The sweet orange is well known throughout the tropics and subtropics. While Florida in general is recognized as an orange-growing state, soil conditions in southern Florida are not ideal for commercial orange production.

The sweet orange is hardier than the lime or lemon, and will withstand more cold and adverse conditions. One of the chief reasons for the fruits being of poor quality when grown on the sandy soils of this region is their tendency to dry out on ripening, the time of ripening coinciding with the advent of the dry season. As long as there is fruit on the tree, frequent irrigation during the dry season is necessary. With early or mid-season varieties, the tree may be allowed a rest period after the fruit has been picked, but at first sign of new growth in spring the trees should be fertilized and irrigated in order to force an even flush of growth and bloom; from this time on, the tree should not be allowed to suffer for lack of water. In southern Florida there is often a prolonged dry spell during the summer months. At such a time the fruits slow up in development and the skin becomes tough. As a result, the fruit cannot expand sufficiently to absorb the heavy influx of sap following the next heavy rain; this is the chief reason why so many split oranges are found on the trees in the late summer and fall.

The first oranges were presumably introduced into Florida by the Spaniards. In the early days the trees were grown from seed, thus giving rise to numerous types and local varieties, which did not reproduce types true from seed. The advent of budding and the introduction of new varieties from other countries, especially from the Mediterranean region, gave a further impetus to the number of varieties offered for sale by plant-growers. Most of these early varieties have not stood the test of commercial orchardizing and have gradually dropped out. The budded varieties now offered for sale by reputable nurserymen may be accepted as worth while varieties, being the result of a careful selection over a period of years.

Seedlings of the sweet orange do not make satisfactory root-stocks

in southern Florida. The rough lemon, sour orange, and grapefruit are the most satisfactory stocks. There is also the question of compatibility of root-stock for the desired variety. The grapefruit stock is too strong-growing for some of the orange varieties of finer-growth type. It is best adapted to the low, wet soils where a shallow, spready root system is necessary. For the deep, well-drained, sandy soils, the rough lemon root-stock is the most suitable. It throws taproots deep into the moist substrata and withstands drought exceedingly well. It again is not a compatible root-stock for certain varieties, and fruits have a tendency to become coarse on this stock unless care is taken in fertilizing. It is a vigorous grower on poor dry soils and large amounts of nitrogen should be avoided, heavier applications of phosphate and potash being advantageous. The sour orange is the most suitable root-stock for general purposes and is the best for medium, well-drained soils; it develops several taproots, although most of its roots are in the upper soil strata. On low, wet soils, drainage must be provided to prevent water logging, while on dry sandy and rocky soils a heavy mulching is advisable. The mulch layer should extend out as far as the branches spread. Frequent irrigation during dry spells is essential.

The varieties of the sweet orange most commonly planted for home use are: Parson Brown, an early variety of medium size; pineapple, a mid-season variety of good size, juicy, and of good flavor; Valencia, a late-maturing variety, with medium-sized fruit of good quality; navel, a mid-season variety, with medium to large fruit. There is so much variation in the quality of the navel orange that care should be used in purchasing the plants.

Citrus hybrids

The limequat is a hybrid between the oblong kumquat (*Fortunella*) and the Mexican or key lime. It is quite hardy in southern Florida and appears to be adaptable to more trying conditions than is the lime. The tree is a good grower, the slender branches usually being weighed down by the fruit. It is a prolific bearer and is well worthy of space in every home-yard planting. The fruit is oblong, averaging larger than the kumquat, with a smooth, thin skin. It is quite acid and is valuable for "ades" and for flavoring. The Eustis is the only horticultural variety at present offered for sale by growers.

The tangelo is a hybrid between the pomelo or grapefruit and the tangerine. The fruit is thick-skinned like a grapefruit but peels readily. It is the size of a small grapefruit and slightly pear-shaped. Its chief appeal lies in its distinctive flavor as a breakfast fruit. The fruit dries

out readily on the tree after ripening, and becomes dry and spongy if allowed to remain on the tree.

The Sampson and the Thornton are the two chief varieties offered for sale by growers at the present time.

Hindsia japonica

The kumquat (*Hindsia japonica*), is a native of eastern Asia, but has been established in many other parts of the world. It is frequently grown as an ornamental tub plant, but is a valuable fruit for preserving as well as for eating out of hand.

The kumquat has been grown in the northern part of Florida for many years and is quite hardy. It is able to withstand several degrees of frost without material damage. It is successful in southern Florida but requires heavy feeding on the light sandy soils for the production of good fruit. The fruit is round or oblong; the pulp is acid, while the peel is sweet and aromatic. The fruit ripens in the late fall and remains on the tree all winter. The tree is a heavy bearer, but frequent irrigations are necessary at intervals throughout the dry season in order to maintain the water content.

Nagami is a variety of a stocky, robust growth and is quite productive. The fruits are oblong, of an orange color, and average one and a half inches in length.

Marumi has round fruits averaging slightly over an inch in diameter and deep orange in color. It has a stocky, compact growth with short, sharp thorns on the branches and older twigs.

Meiwa has round fruits about an inch and a half in diameter, of an orange-yellow color; it is quite productive and of good quality.

Aegle

The genus *Aegle* contains only one species, *Aegle marmelos,* the bael fruit, of northern India, where it is much prized. It is a small tree with spiny branches and trifoliolate leaves, is quite hardy, and should prove an interesting addition to our collection of fruits for southern Florida.

The fruit, about the size of an orange, has a hard shell enclosing a soft, aromatic pulp in which the seeds are embedded. When ripe, the pulp is sweet and of a pleasant flavor and is used chiefly in making refreshing drinks or sherbets. It is claimed to have a salutary effect on the digestive system.

Wester gives the following analysis, by percentages, from the Philippines: Water, 54.96; ash, 1.04; protein, 2.62; carbohydrates, 28.11; sugar, 5.80; acidity (tartaric), 2.11.

Casimiroa

Of the several species of *Casimiroa* indigenous to Central America, only two are grown for their edible fruits, *Casimiroa edulis* and *C. tetrameria.*

The white sapote (*Casimiroa edulis*), is an open-growing tree with brittle branches, and is quite striking in appearance with its dark, glossy leaves and rough, grayish bark.

The fruits turn yellow when ripe and vary in size from that of a tomato to an orange. The thin skin encloses a soft yellow pulp of a peculiar though agreeable flavor; embedded in the pulp are from three to five large round seeds. It is a dessert fruit and not suitable for cooking, but may be used in sherbets.

There is a great deal of variation among seedling trees, most of them having fruits with a slightly bitter aftertaste. Some good-flavored types are now being grafted and tested in experimental plantings; some of them should be available for general planting in the near future. The tree is tender when young but becomes fairly hardy on developing woody tissues. It has proved to be quite hardy in southern Florida and is adaptable to the light soils. On the shallow, rocky soils it is apt to suffer from chlorosis if not supplied with a sufficient amount of organic manure. Some of the bitter taste in the fruits is caused by insufficient water during the period of fruit development.

Popenoe quotes the following analysis, by percentages, after the University of California: Water, 72.64; ash, 0.44; protein, 0.64; sugars, 20.64; fat, 0.46; crude fiber, 1.26; carbohydrates (not sugars), 3.92.

Casimiroa tetrameria

The Matasano (*Casimiroa tetrameria*), is a stronger-growing species than *C. edulis*. In growth it is inclined to be more open and spready; the leaves are larger and rough to the touch; the young growth is quite fuzzy. The fruit is considerably larger than that of *C. edulis* and is considered by some to be superior in flavor. Some of the seedling trees are very promising and produce large fruits of good flavor with practically no bitter aftertaste. Some good seedling types are now under observation and should soon be available for general planting. The Matasano is a desirable fruit and deserves a place in the home planting.

Clausena

The wampi (*Clausena lansium*), is of Chinese origin. It is a small tree reaching a height of fifteen to twenty feet with pinnate leaves; the

foliage is of a medium shade of green, the leaflets being from three to six inches long and two to three inches wide.

The fruits are the size of grapes and are borne in clusters; they are pale yellow when ripe and have a rough skin. The skin is easily split and the aromatic, jelly-like inner pulp is readily popped out. Embedded in the semi-transparent sweetish pulp are five or six small, brown seeds. It is really a dessert fruit, although good pies may be made from the pulp, the seeds not being disagreeable. The more acid types may be used to make jelly when green, and fruit drinks when ripe.

There is much difference between trees grown from seed, and so far there have not been a sufficient number of them fruiting in southern Florida to permit a selection of better types. The tree is quite hardy and is adaptable to the rocky and the deep sandy soils of southern Florida. It is susceptible to chlorosis on the alkaline soils and requires organic fertilizer or barnyard manure. It fruits in July and August and is well worth planting. Better types will have to be propagated by budding or grafting. In the Philippines it has been successfully budded on the regular *Citrus* root-stocks.

This species is a fairly clean grower and does not require special pruning, beyond a little thinning out of the top to prevent overcrowding from sucker shoots.

Triphasia

The Chinese lime or limoncito (*Triphasia trifoliata*), a native of tropical Asia, is a dwarf, compact-growing bush with spiny branchlets and small, dark-green, glossy leaves, each with three leaflets.

The fruits are small, oval-round, about an inch in diameter, and dark red with small white splotches on the skin. The flavor is sweet, aromatic, and mildly acid with a resinous flavor. The plant is usually considered to be more of ornamental than of commercial value. The ripe fruits may be eaten out of hand or used in "ades" or candied; the fully grown, partly ripe fruits make a distinctive jelly. The Chinese lime is hardy and appears to be adaptable to a wide range of soils, providing they are well-drained. It responds to good treatment and does not seem to have any special cultural requirements.

Wester quotes the following analysis, by percentages, from the Philippines: Waste, 20.00; water, 80.80; ash, 1.05; protein, 1.40; sugar, 4.90; acid, 0.24.

SAPINDACEAE

The Sapindaceae or soapberry family, contains two genera of interest for southern Florida, *Litchi* and *Euphoria*. *Blighia* and *Melicocca* may

be considered more as ornamentals than as economic fruit trees. Two other fruits well known in the eastern tropics are the rambutan (*Nephelium lappaceum*) and the pulsan (*N. mutabile*). These, however, are strictly tropical and have not been successful in Florida. The plant-breeder may be able to do something with them in creating successful hybrids, but at present they may be considered simply as experimental material.

Blighia

The akee or vegetable brain (*Blighia sapida*), is a native of West Africa; it is said to have been brought to the West Indies in slave days.

The fruits are about three inches long, triangular in shape, with a thick, leathery, red shell which opens in three sections when ripe. The shell sections fold back, exposing the white, brain-like, nutty arils with a shiny black seed embedded in each. The aril is good to eat when fresh, either raw or cooked; it is usually parboiled and fried. Having a high percentage of oil, it soon becomes rancid and unfit to eat; the pink tissue embedded between the creamy-white lobes is considered to be poisonous and should be removed.

The tree is tender when young but is quite hardy on attaining partial maturity; mature trees have been known to withstand several degrees of frost. It is a quick grower and responds well to feeding, and is quite adaptable to the well-drained sandy soils of southern Florida. It is inclined to be a straggly, open grower and requires frequent pruning to keep it in shape. It seems to be very susceptible to attacks by scale and mealybug.

The fruit is in great demand by the colored residents of the islands of the British West Indies, and the tree is grown in almost every back yard. When in fruit it is interesting and very ornamental with its coarse, compound leaves and red fruit. Because of the tendency of its fruits to spoil quickly, it cannot be recommended for general use as commercial fruit.

Euphoria

The longan (*Euphoria longana*), is commonly known in China as the "little brother of the litchi." It is much hardier than the litchi, being more resistant to cold and more adaptable to different soil conditions. It is quite hardy in southern Florida and may prove to be valuable as a root-stock for the litchi in the drier sandy soils.

The tree matures its fruits later than the litchi, and they are smaller, smoother and not so highly colored. They are not so sweet in flavor

but are more piquant than those of the litchi. The fruits are eaten fresh, dried, or preserved.

The tree is handsome and of a uniform growth, with dense, dark-green foliage; the leaves are compound, the leaflets being shiny, of a leathery texture, quite hardy and wind-resistant.

Although adaptable to various soil conditions, the tree thrives best on well-drained soils; heavy mulch and organic manures are advisable on light sandy soils. As it fruits during the late summer and fall, it should be allowed to go as dormant as conditions will allow during the winter season.

The longan grows with a compact head but does not require any special pruning beyond a thinning out of weak inside branches. The fruiting occurs on the branch tips, where it receives sufficient light and air for development. It is a tree well worth growing in the home collection.

Wester gives the following analysis, by percentages, for the fruit: Water, 82.39; protein, 1.41; sugar, 8.34; crude fiber, 0.63; fat, 0.45. Calories per kilo of food: 430.

Litchi

The litchi (*Litchi chinensis*), one of the famous and favorite fruits of southern China, has possibilities of becoming one of the commercial fruits of southern Florida. The dried fruits are known in the northern markets, being imported from China, where they are highly prized in this form or when preserved in syrup. This is one of the very best fruits known, and one should not judge it by the dried and preserved forms that one finds in the northern markets.

In southern Florida the tree has proved to be adaptable to the climatic conditions, but requires more nourishment than these light soils alone can provide. Where supplied with plenty of organic fertilizer or manures, it has fruited well and matured its fruits in good condition.

The plants are tender when young and the roots are very intolerant of ordinary conditions. After striking out their secondary roots, they appear to overcome this tenderness and the tree makes a good growth if well nourished.

The tree is very striking when in fruit; the fruits are borne in open panicles that droop as they increase in weight, so that when ripe they look like clusters of ripe strawberries hanging from the ends of the twigs. The fruits are round, about an inch and a half in diameter, with a rough, brittle shell easily opened, from which pops the firm, whitish,

gelatinous pulp in which is embedded the oval, blackish seed. The pulp is sweet, mildly acid, and of a very agreeable flavor.

The tree is quite handsome, being fairly uniform in growth with a round, dense top. The leaves are compound, forming from two to four pairs of leaflets about three inches in length, glossy and dark green above and grayish green on the underside; the bark is grayish brown and rough.

There are many recognized horticultural varieties in China where each district has its favorite strains. So far there are no distinct horticultural varieties available in Florida, where nearly all the plants at present available are seedlings. There are numerous young trees under observation in test plantings and it is hoped that some superior strains will be available in the near future.

Wester quotes the following analysis for dried fruit, by percentages: Water, 17.90; protein, 2.90; carbohydrates, 77.50; ash, 1.50; fat, 0.20. Calories per kilo of food: 3234.

Popenoe quotes the analysis of the fresh fruit from Hawaii, by percentages, as having: Total solids, 20.92; acids, 1.16; total sugars, 15.30; ash, 0.54; protein, 1.15.

Melicocca

The Spanish lime (*Melicocca bijuga*), is a native of Central America and the West Indies, where its fruit is a general favorite with children. It is a shapely evergreen tree of upright growth, the top becoming spready on reaching maturity. The light green foliage always has a fresh, clean appearance; the grayish bark of the trunk and main limbs makes the tree very attractive. It is worthy of wider distribution in southern Florida if only as an ornamental tree.

The Spanish lime is fairly hardy on attaining some maturity. It grows well on the light sandy soils, doing exceedingly well on the shallow rocky soils at Key West, where it is quite abundant, and where the fruit is in great demand.

The round, smooth, green fruits are borne in clusters, and are about one inch in diameter. The tough, leathery skin or shell contains one large seed surrounded by a gelatinous mass of soft, juicy pulp. In eating the fruit, the shell is cracked and the inside popped into the mouth by squeezing the shell.

So far the trees have been grown from seed and no horticultural varieties are offered for sale. There is much difference in the quality of the fruits, ranging from small, acid fruits to large, sweet, juicy ones. The Spanish lime is an interesting fruit and has an appealing flavor on

a hot day, but cannot be considered to be of much value for the menu.

Cardenas and Moreno give the following analysis, by percentages, for Cuban fruits: Water, 80.80; fats, 0.22; carbohydrates, 1.40; ash, 0.50; protein, 0.50; sugars, 12.10; fiber, 2.60. Coefficient of digestibility: Protein, 90.00; fats, 91.00; carbohydrates, 94.00.

SAPOTACEAE

There are over thirty genera in the Sapotaceae family, mostly in the tropics and subtropics of both hemispheres.

All the members of this family have a milky sap, some of which has commercial value, such as gutta percha and chicle, the latter produced by *Achras zapota*, which is extensively used for manufacturing chewing gum.

In their analyses of Cuban fruits, Cardenas and Moreno state that the fruits of *Achras*, *Calocarpum*, and *Chrysophyllum* are outstanding for the high percentage of chlorine in their ash.

Achras

The sapodilla (*Achras zapota*), is one of the outstanding fruits of tropical America. It supposedly originated in southern Mexico, where it grows wild and displays great variation in seedling types.

The tree is handsome, with a dense head of dark, glossy leaves and gray-brown bark. The leathery leaves vary in size but average about four inches in length; they are elliptical and are usually pointed, dark, glossy green on the upper surface and pale green underneath. It is evergreen and makes a very desirable shade tree.

The fruits vary in shape and size. Up to now the trees have been grown from seed, which results in much variation in size and quality of fruit and in productivity. So far no horticultural varieties have appeared on the market, although some selected types have been grafted for test plantings in southern Florida.

The fruits are round, oval, or roundish and flat, the last-named variety being known as the saucer dilly. The difference in quality of the fruits runs through all types, and there does not appear to be any marked superiority as between the forms of the fruit. The leathery skin is rough and brownish. The flesh is pale brown, somewhat granular, soft and sweet, and of a very agreeable flavor. The seeds are black or brown, oval and flattish, hard and glossy, and are set with geometrical exactness around the soft center.

The sapodilla is fairly well established throughout the warmer regions

of the world. In southern Florida it is quite hardy, being at home equally well in the rocky and in the deep sandy soils. It appears to be very well adapted to conditions on the Florida Keys, where several desirable types are to be found.

Young trees should be well nourished and given plenty of water. After the third or fourth year they will be well established and quite hardy, having by that time extended taproots into the lower moist strata. While the tree is to be found in an almost uncultivated condition throughout the Florida Keys, it responds to treatment, and especially on the deep sandy soils should be mulched for the greater benefit of the surface feed roots.

The tree is not a very fast grower and requires little pruning, being self-shedding; that is, the twigs shed readily as they die, so that the tree has always a clean, tidy appearance.

The sapodilla is a dessert fruit; efforts at cooking it result in a mess of rubbery pulp. The ripe fruit may be pulped and used for sherbets or in ice cream, the pulp being mixed with the cooled custard just before the mixture is put into the freezer.

Cardenas and Moreno give the following analysis, in percentages, from Cuba: *Round sapote:* Water, 78.00; protein, 0.40; fats, 0.50; sugars, 11.20; carbohydrates (not sugars), 2.24; fiber, 7.00; acids, 0.16; ash, 0.50. Coefficient of digestibility: Protein, 86.00; fats, 96.00; carbohydrates, 85.00. *Oval sapote:* Water, 77.80; protein, 0.60; fats, 0.55; carbohydrates (not sugars), 2.20; fiber, 5.35; acids, 0.25; ash, 0.55; sugars, 12.70. Coefficient of digestibility: Protein, 86.00; fats, 96.00; carbohydrates, 86.00.

Calocarpum

The mamey zapote, mamey colorado or red sapote (*Calocarpum sapota, C. mammosum*), is a favorite fruit throughout the West Indies and Central America. It is indigenous to the American tropics, and wherever grown is relished as one of the more desirable fruits.

In rich soils throughout the tropics the tree often reaches a height of one hundred feet. In Cuba it is more inclined toward a spready growth, and seldom reaches more than fifty or sixty feet in height. The leaves vary from six to ten inches in length and from three to four inches in width; they are dark green on the upper surface and pale green beneath; the young leaves often have a brownish tinge. The young tree is handsome, but it rapidly becomes open and straggly in growth on reaching maturity.

The small flowers are produced in profusion along the younger branches, only a few surviving to produce fruit. The fruit is elliptic, from five to eight inches long, with a rough scaly, grayish-brown skin somewhat leathery in texture. The flesh is soft, terra cotta in color and granular, enclosing one or two long, hard-shelled, glossy brown seeds. The flesh is rich and sweet; it may be eaten on the half shell with a spoon, the addition of a little salt or lime juice being preferred by some. This is not a cooking fruit, and is perhaps at its best when made into sherbet.

The young plants are very tender but become hardier as they develop woody growth. The large, soft leaves are easily injured by cold winds, and the tree should be planted in a location sheltered from north and northwest winds. So far the trees have been grown from seed selection, and vegetative propagation has been neglected. There are quite a number of young trees making satisfactory development in scattered locations throughout southern Florida. One old tree in Redlands has been fruiting for a number of years and appears to be perfectly at home, with its octopus-like roots spreading out over the rocks and disappearing down the potholes.

The fruit is worthy of more attention as a possibility for southern Florida; it is hoped that some of the trees now approaching fruiting age will prove to be worthy of vegetative propagation.

Analysis of the fruit, by percentages, is given from Cuba by Cardenas and Moreno: Water, 70.00; fats, 0.25; carbohydrates, 1.50; ash, 0.90; protein, 1.15; sugars, 23.00; fiber, 3.20. Coefficient of digestibility: Protein, 85.00; fats, 92.00; carbohydrates, 92.00.

Chrysophyllum

The star apple or caimito (*Chrysophyllum caimito*), is indigenous to Central America, and is another of the favorite fruits of the West Indies, where it is extensively grown.

The tree is handsome with its dark-green, glossy leaves, the underside being silky and varying in color from silvery in the young leaves to russet brown in the mature ones. They are very showy in a breeze. In growth the limbs have an upward direction, while the long, slender, lesser branches and twigs have a partly pendant form, making a very graceful tree.

The flowers are small and insignificant, being scattered along the mature twigs, where they are partly hidden by the foliage. The fruits are round or roundish-flat, averaging three inches in diameter, with a

smooth, thick, tough skin covering the sweet granular flesh. The star apple is one of the fruits the beginner usually likes at first taste; the flesh being soft and of an agreeable flavor. It is strictly a dessert fruit and may not be cooked.

In southern Florida the tree does not reach the height it does in the heavier soils of the West Indies and also tends toward a slower and more open growth. It seems to be quite adaptable to the light sandy soils of southern Florida, but requires organic fertilizers or manure for good growth. It requires large amounts of water on these well-drained soils for good fruit development, but will not tolerate too much wetness or poor drainage. Mulching is advisable.

With the star apple, two types or strains are recognized, the morado, or purple and the blanco, or white. There is very little difference in flavor between the two, although the purple one is generally considered to be the more flavorsome, while the white is sweeter. The trees are grown from seed at present, and the usual variation in productiveness and size and quality of fruits are to be found among the seedling trees. So far no systematic research has been made with a view to selection of superior strains for vegetative reproduction.

There are quite a few fruiting trees in southern Florida, and the star apple bids fair to become one of the commercial fruits in the near future. It is also a good shipping fruit for market purposes. The star apple gets its name from the location or placement of the black, glossy seeds, which are set in the flesh around the soft center, forming a five-pointed star.

The young plants are tender and should be planted in locations sheltered from the cold north and northwest winds. It is one of the hard-wooded, thin-barked trees that suffer readily and recover slowly from shock or mechanical damage. The tree has a free and graceful style of growth and does not require special pruning.

Cardenas and Moreno give the following analysis, by percentages, from Cuba: *Caimito blanco:* Water, 83.00; protein, 0.80; fats, 0.40; sugars, 9.55; carbohydrates (not sugars), 2.20; fiber, 3.50; ash, 0.53. Coefficient of digestibility: Protein, 80.00; fats, 91.00; carbohydrates, 94.00. *Caimito morado:* Water, 84.75; protein, 0.90; fats, 0.37; sugars, 8.10; carbohydrates (not sugars), 2.10; fiber, 3.32; ash, 0.46. Coefficient of digestibility: Protein, 81.00; fats, 91.00; carbohydrates, 94.00.

Cardenas and Moreno state: "The acidity of this fruit is insignificant and has therefore not been calculated. The analysis shows that the blanco is superior to the morado from an alimentary point of view, its nutritive capacity residing in the sugar it contains, in which the glucose content is more than double that of the sucrose. In this fruit there is

also an appreciable quantity of potash and phosphoric acid; as a phosphatic fruit it ranks with the sugar apple, which also contains an appreciable amount of this valuable element."

Chrysophyllum oliviforme

The satin leaf (*Chrysophyllum oliviforme*), is often mistaken for the star apple in southern Florida. The leaves are similar to those of the star apple but somewhat smaller; the tree is more slender in growth, although very similar to the star apple when young. The fruits are oval and black and are about one inch in length with one large seed.

The tree grows in southern Florida to about twenty feet in height and is strictly ornamental, the fruit having no commercial value.

Lucuma

The ties or eggfruit (*Lucuma nervosa*), is a native of Central America. It is commonly grown throughout the West Indies, where it is known as canistel. It is a fruit which one either likes or decidedly does not like, because of its peculiar musky flavor.

In southern Florida the tree reaches a height of about twenty feet. It is of open growth, with the leaves usually bunched on the newer growth at the ends of the branches. The leaves are from six to eight inches long, two or three inches wide and rather pointed, of a medium glossy green on the upper surface and lighter on the underside.

The inconspicuous flowers are found on the mature twigs. The fruits are three to four inches long, roundish, with a sharp point or beak, and pale yellow to orange when ripe. The skin proper is thin and papery; it covers a soft, shell-like part that is edible yet harder than the soft, mealy interior pulp, which resembles in color and consistency the dry, hard-boiled yolk of egg. The flavor is sweet and somewhat musky, relished by some people yet disagreeable to others; it is rich and somewhat cloying. There are usually from one to three oval, brown, hard-shelled, glossy seeds about an inch in length, like miniature mamey colorado seeds.

The fruit is easily bruised and is a poor shipper, and at present is more of a home-yard plant. It is usually eaten fresh out of hand, some people preferring it with a pinch of salt or a touch of lemon juice, or it may be used in custards or sherbets. The flavor is usually intensified by cooking; the uncooked pulp may be mixed with ice cream custard after cooling and just before putting it into the freezer.

The tree is quite hardy in southern Florida, and even as a young

plant it is adaptable to the light sandy soils. It responds to good nourishment, and the size and quality of the fruit is greatly improved by fertilizer and irrigation during the period of development.

The egg fruit has a fairly uniform style of growth and does not require special pruning. The wood is soft and somewhat brittle, so that the limbs should not be allowed to become over-extended.

At present there are no horticultural varieties offered by growers. Plants are grown from seed, and so far there is no record of a systematic study having been made with a view to the selection of superior strains. There is much difference in the fruiting qualities of individual trees, some types fruiting twice a year. Several other species of *Lucuma* have been planted in test plantings, but their value is more as ornamental than as fruit producing plants.

Wester and Francisco give the following analysis of the canistel, by percentages, from the Philippine Islands: Moisture, 62.19; ash, 0.11; protein, 1.14; sugars, 9.10; fats (ether extract), 1.18; crude fiber, 1.29; other carbohydrates, 24.99. Weight: 70.16 grams. Weight of edible portion: 45.75 grams. Caloric value per 100 grams: 160.71.

Mimusops

Several species of *Mimusops* have been fruiting in test plantings. The fruits are somewhat small and are of little economic value. The most widely known species is the Asiatic *Mimusops elengi.* For southern Florida they may have possible use as dwarfing root-stocks for other Sapotaceae or as ornamentals for landscape plantings.

VITACEAE

The family Vitaceae has a wide representation throughout the warmer parts of the world. The most widely known representatives of this family are species of the genus *Vitis,* to which the grape belongs.

The other members of this family are chiefly ornamental, *Ampelopsis, Cissus,* and *Parthenocissus* being grown for this purpose. The genus *Leea* contains ornamental foliage and flowering shrubs from tropical Asia. The genus *Tetrastigma* is chiefly tropical and is grown both as an ornamental and as a fruiting vine.

Small mentions *Vitis* (*Muscadina*) *munsoniana* as growing in southern Florida; it occurs in hammocks and the upper keys. It has small berries, 1 to 1.5 cm. in diameter, with tender skin and acid pulp; this is commonly known as the Bullace grape. He also mentions two species of *Cissus* as having acid, inedible berries, and one species of *Parthenocissus, P. quinquefolia,* commonly known as the Virginia creeper.

Vitis

The genus *Vitis* contains some fifty species, chiefly of the north temperate zone. Some of the species are purely ornamental, while some have high commercial value as fruiting vines. *Vitis vinifera* is the wine grape of the Old World.

Among the American forms, *Vitis aestivalis* is the species from which some of the best wine-making varieties of the Southern States have been derived. *V. riparia* is used as a disease-resistant root-stock for the phylloxera susceptible European varieties, both in the United States and in Europe. *V. rotundifolia* is the southern muscadine or bull grape, from which came the Scuppernong variety.

Southern Florida is not a grape-growing region. While Small mentions several species as growing wild throughout the hammocks and the keys, the climate is not suitable for the commercial growing of the present existing varieties. The mildews are especially bad, and while this trouble can be controlled the results do not warrant the cost involved. The fruits of the present commercial varieties of grape do not develop properly under southern Florida conditions. It is quite possible for the plant-breeder to develop a grape suitable for southern Florida, but it would have to be something distinctive, with a special market appeal, to enable this section to compete with the other grape-growing regions of the United States.

Small mentions *Vitis tiliaefolia* (*V. caribaea*) and *V. coriacea* as growing wild throughout the hammocks and keys; these species are wild throughout the Bahamas and West Indies. *V. simpsoni*, growing in the dry sandy thickets and woods of peninsular Florida, is supposedly a hybrid and shows much variation in type. These wild species may be readily grown on a trellis or fence should grapes be desired for jelly-making.

Tetrastigma

There are some forty or fifty species of *Tetrastigma* throughout tropical and subtropical Asia. Most or all of them have an inferior or inedible fruit. The only species that we have had experience with in southern Florida is *Tetrastigma harmandi*; this species was introduced by the United States Department of Agriculture from the Philippines.

Tetrastigma harmandi is a strong-growing vine; climbing by tendrils, it has three to six palmately arranged, short-stalked, glossy leaflets. The fruits are borne in bunches or clusters; they average three-quarters of an inch in diameter and have a tough, brown skin and a pleasantly acid pulp containing two or three seeds. This is an excellent jelly fruit

and when fully ripe the flavor is somewhat similar to that of the Scuppernong grape.

This vine has been growing in southern Florida for quite a number of years as an ornamental plant. It is a self-climber by means of its tendrils; it is a rapid grower, and soon makes a thick cover on a trellis or on wires on a wall.

For fruit-bearing, the vine should be grown on a wall or fence having an open, sunny exposure. It does not fruit well in the shade or where it is allowed to grow dense. There is much variation in bearing qualities among seedling plants, and the vine should therefore be propagated by cuttings selected from good bearing plants. Pruning in the spring is advisable, in order to restrict the overabundance of young shoots and open up the older shoots to the sun so as to encourage fruiting. As the vine has a tendency to over-rank growth, it is advisable to avoid high-nitrogen fertilizers.

Wester quotes the following analysis, by percentages, for *Tetrastigma harmandi,* from the Philippines: Water, 90.96; ash, 1.40; protein, 0.02; sugar, 0.62; acidity (as citric), 1.02.

IMPROVEMENTS

In the discussion of fruits mentioned in this book it must be understood that they are not at the present moment being put forward as commercial orchard possibilities; several years' study and experimentation will be necessary in order to develop this possibility for any particular species.

Most of these tropical plants have developed their characteristics in soils rich in minerals and humus. For them to become adapted to the light, sandy soils of southern Florida, a certain amount of readjustment is necessary in the root formation. This in turn affects the form and development of the upper parts of the plant; there is generally a slight modification in type of growth from that in the native habitat. Altitude and length of growing season influence the development and maturity to some extent. Some of the plants, accustomed to the short growing and long dormant seasons of the higher altitudes, do not mature their growth sufficiently in low altitudes for the proper development of flower buds.

Plant metabolism (the building up and breaking down of plant tissue) is influenced day by day by the environment, soil conditions, atmospheric conditions, light, temperature, etc. These conditions influence the development of the plant to such an extent that only those plants that are able to adapt themselves can survive.

A batch of seedlings from one of these plant immigrants will show a great deal of variation in general development; a few are strong, a greater number are weak, and the majority are of average development. Each plant generation shows further progress toward adaptation to the new environment, with the more adaptable plants surviving. Selection of desirable types from among these seedlings will hasten the rate of progress. Such a work requires steady application of effort, and must be conducted over a period of years in an experimental garden organized specially for this purpose. At present most of this work is being done in an unorganized manner by amateurs. It may be that the recently organized Fairchild Tropical Garden in Coconut Grove will be able to assume leadership in this field.

Plants have a surprising range of adaptability; they seem to have a "will to live" and a plasticity in adapting themselves to new environments. As a general rule, shrubs are hardier and are more readily adaptable to a new environment than are trees; the rate of progress in acclimatization of shrubs is more rapid than that of trees, the life cycle, as a rule, being shorter.

The adaptability of plants is an interesting study. Many of the fruiting plants of tropical origin have proved that they can become adjusted to the soil and climatic conditions of southern Florida. A number of these are at present in the borderline class and require protection and special care, but it is to be expected that succeeding generations of seedlings will gradually acquire greater hardiness.

There is also the ever-present possibility of mutations, through which the long route of acquired hardiness may be shortened. Every cold spell, or frost, gives an added opportunity for observation and accumulation of valuable data along these lines.

A third class of plants includes those too tender for general planting and suitable at present only for experimental plantings. They have potential value as breeding material for hybridization with hardy species in the development of new and more desirable strains.

Plant improvement through new varieties or strains is popularly understood to be secured through hybridization, either by natural agency or through the efforts of the plant-breeder. While many new varieties are produced in this manner, chiefly among the garden or flowering plants, we owe many of our improved strains of flowering plants and fruiting trees and shrubs to mutations or sports, as they are commonly called.

A change in environment may be a contributing cause of mutations. Sometimes mutations appear without any apparent stimulating cause,

and in that case their appearance may be attributed to some inherent tendency toward variation in the plant itself. They are often very noticeable in ornamental foliage plants, and such variations have been perpetuated by asexual methods of propagation. In fruiting plants they are not so noticeable. Many plants have considerable variations within their specific limits, and it would seem possible that this tendency might be stimulated in those plants of recent introduction, now being planted in southern Florida, in different soil and climatic conditions from those of their origin.

Anyone interested in plants readily observes the differences in type apparent in a batch of seedlings, be it a flower bed or a group of trees, but very few people notice the differences between branches on a tree or a shrub. The existence of this variation is an important fact to keep in mind should one be interested in plant improvement; it may prove to be valuable when least expected. In plants there is variation everywhere, some of it seasonal, some permanent. Most of these changes are of minor importance, but once in a while a valuable variation may be found.

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